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# DEVELOPMENT OF FATIGUE DATA FOR SEVERAL ALLOYS FOR USE IN AEROSPACE DESIGN

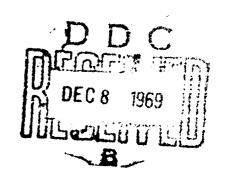
T. A. Roach -

Standard Pressed Steel Co.

Technical Report AFML-TR-69-175

June, 1969

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#### DEVELOPMENT OF FATIGUE DATA FOR SEVERAL ALLOYS FOR USE IN AEROSPACE DESIGN

T. A. Roach

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#### FOREWORD

This report presents the results of work performed by Standard Pressed Steel Co., Jenkintown, Pa. under contract to the Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base Ohio 45433. The work was performed under Air Force Contract AF33(615)-3737 which was initiated under Project No. 7381, "Materials Applications", Task No. 738106, "Engineering and Design Data". The Air Force Project Engineer was Mr. Clay Harmsworth (MAAM).

This report covers work in the period March 1966 to November 1968. The manuscript of this report was released by the author in May 1969 for publication as a Technical Report.

This report was prepared by Thomas A. Roach.

This technical report has been reviewed and is approved.

A. OLEVITCH

Chief, Materials Engineering Branch Materials Support Division Air Force Materials Laboratory

#### ABSTRACT

A test program was conducted to develop fatigue data on 17-7 PH and PH 15-7 stainless steels at room and elevated temperatures. Limited stress-rupture and tensile data were also obtained. This program is part of an overall effort to obtain fatigue data for alloys which are currently in MIL-HDBK-5, but for which fatigue data is currently lacking. All data were generated to be compatible with the MIL-HDBK-5 format and are presented in tabular form as well as stress rupture curves, S-N curves, and constant life diagrams.

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#### SECTION I

#### INTRODUCTION

The importance of using fatigue data for the selection of structural materials and the design of aerospace systems has been well recognized in recent years. However, there are many gaps where data doesn't exist, or is incomplete for alloys which are otherwise well characterized in Mil-Handbook 5. It was the purpose of this program to obtain axial fatigue data and fill some of these more critical areas by supplying S-N curves and constant life curves.

The program obtained axial loading fatigue data for several alloys -- AM350, 17-7 PH, and PH 15-7 Mo -- at room and elevated temperature in the unnotched and notched conditions. In addition, limited tensile and stress rupture data to complement the fatigue data were obtained.

The selected materials are alloys now included in Mil-Handbook 5 and are covered by AMS or Mil specifications. The tests were designed to provide data that will be applicable to the Mil-Handbook 5 format.

#### SECTION II

#### PROGRAM DESCRIPTION

#### A. Materials and Conditions

The test materials consisted of AM 350 sheet in the sub-zero cooled and tempered (SCT) condition, 17-7 PH, and PH 15-7 Mo sheet and forging in the RH 950 and TH 1050 condition. All of these materials were purchased in the annealed condition and heat treated by Standard Pressed Steel Co. The materials included are summarized in Table I.

TABLE I

SELECTED MATERIALS & CONDITIONS FOR TESTING

Alloy	Condition	Form	Thickness
AM350	SCT	Sheet	.050 inches
17-7 PH	TH 1050	Sheet	.050 inches
17-7 PH	TH 1050	Forging	
17-7 PH	RH 950	Sheet	
17-7 PH	RH 950	Forging	. vov menos
PH 15-7 Mo	TH 1050	Sheet	.050 inches
PH 15-7 Mo	TH 1050	Forging	
PH 15-7 Mo	RH 950	Sheet	.050 inches
PH 15-7 Mo	RH 950	Forging	

#### B. Test Program

The primary portion of this program consisted of axial fatigue tests of AM350 sheet, 17-7 PH sheet and forgings and PH 15-7 Mo sheet and forgings. Sufficient tensile and stress-rupture tests were performed to provide the basis for fatigue tests and provide the necessary data for the completion of characteristic constant life diagrams. The tests on the AM 350 (SCT) and 17-7 PH (1050) sheet were conducted at the Air Force Materials Laboratory and will be reported separately.

Fatigue tests were run at three specified alternating stress/mean stress ratios (A ratio), various temperatures on notched and smooth specimens at varied heat treatment levels. Stress levels were varied to produce a complete S-N curve on each lot of specimens to provide the data necessary for the constant life diagram. The entire program is summarized in Tables II, III and IV.

TABLE II
TENSILE TESTS

		*		17	7-7 P	Н	P	H 15.	-7 M	0
	Test Temp, °F	/.M350-SCT Sheet*	TH1050 Sheet*	TH1050 Forging	RH950 Sheet	RH950 Forging	RH950 Sheet	RH950 Forging	TH1050 Sheet	TH1050 Forging
Smooth specimens Longitudinal and Trans- verse (3 tests/condition)										
	R.T.	8	8	6	6	6	_	6	_	_
	500	8	-		_	_	-	_	_	_
	600	-	8	6	6	6	6	6	-	_
	700		-	1	_	-	_	į	6	6
	800	8	8	6	6	6	-	_	_	-
	1000	_	_	-	_	-	6	6	6	6
Notched Specimens Longitudinal and Trans- verse(3 tests/condition)										
$K_t = 3.0$	R.T.	8	8	6	6	6	6	દ	-	_
	500	8	_	_	_	_	_	_	_	_
	600	_	8	6	6	6	6.	6	_	_
	700	_	_	_	_	_	_	_	6	6
	800	8	8	6	6	6	_	-		_
	1000			_	_	_	6	6	6	6

<sup>\*</sup>Specimens to AFML for testing,  $K_t = 3.3$  on these notched specimens

TABLE III
STRESS RUPTURE TESTS

		et*		17-7	PH	•	PI	H 15	-7 M	o
	Test Temp. • F	AM 350-SCT Sheet*	TH 1050 Sheet*	TH 1056 Forging	RH 950 Sheet	RH 950 Forging	RH 950 Sheet	RH 950 Forging	TH 1050 Sheet	TH 1050 Forging
Smooth Specimen	500 600 700 800 1000	6 - 6 -	- 6 - 6	- 5 - 5	5 - 5 -	- 5 - 5		- 5 - 5		5 - 5
Notched Specimen  K <sub>t</sub> = 3.0	600 700 800 1000		111	5	5   5	5   5	5 — — 5	5 — — 5	 5  5	- 5 - 5
Notched Specimen  K <sub>t</sub> = 3, 3	500 600 800	6 — 6	_ 6 6	111	- -		-		1	1 1

<sup>\*</sup> Specimens to AFML for testing.

All sheet specimens transverse All forging specimens longitudinal

TABLE IV

#### FATIGUE TESTS

		*		17-7	PH		PH	15-	7 M	,
	Test Temp. °F	AM350-SCT Sheet*	TH1050 Sheet*	TH1050 Forging	RH950 Sheet	RH950 Forging	RH950 Sheet	RH950 Forging	TH1050 Sheet	TH1050 Forging
Smooth specimens Longitudinal A = 👓 A = 0.98	R.T. 600 700	  -  -	  -  -	20 30 —	_	30 30 —		10 30 —	_ _ _	_ _ 30
A = 0.50 10 tests/condition	800 1000	_	_	30		30	_	30	_	30
Notched Specimens Longitudinal K <sub>t</sub> = 3.0 A = ∞ A = 0.98 A = 0.50 10 tests/condition	R.T. 600 700 800 1000	  -  -  -  -		30 30 — 30 —		30 30 — — 30		30 30  - 30	11111	— 30 — 30
Smooth specimens Transverse A = 0.98 A = 0.50 10 tests/condition	R.T. 500 600 700 800 1000	_ 11 _ _ 22 _	22  22  22		20  20   20	11111	 20  20	11111	_ _ _ 20 _ 20	11111
Notched Specimens Transverse Kt = 3.0 A = 0.98 A = 0.50	R.T. 500 600 700 800 1000	** 11 11 - - 22	22  22  22	_ _ _ _ _	20  20   20	-	20  20   20	1 1 1 1 1		

<sup>\*</sup> Specimens to AFML for testing. \*\* K<sub>t</sub> = 3.3 10 test/condition.

#### C. Specimen Preparation

#### 1. Sheet Specimens

All sheet material was ordered and received in the annealed condition to facilitate specimen manufacture.

Blanks for the specimens were sheared from the sheets 1/32" oversize. They were identified and then heat treated. The specimens were clamped securely during the cycle to prevent distortion. The heat treatment cycles were as follows:

#### AM350 SCT

Anneal by heating to 1710°F and air cooling to room temperature Cool to -100°F and hold for 3 hours
Precipitation harden at 850°F for 3 hours and air cool

#### 17-7 PH RH 950

Destabilize by heating to 1750°F, holding for 10 minutes and cooling to room temperature

Cool to -100°F and hold 8 hours

Precipitation harden at 950°F for 1 hour and air cool

#### 17-7 PH TH 1050

Destabilize by heating to 1400°F, holding 90 minutes and air cooling to room temperature

Cool to 55°F within one hour of the destabilization and hold 30 minutes

Precipitation harden at 1050°F for 90 minutes and air cool

#### PH 15-7 Mo RH 950

Destabilize by heating to 1750°F, holding for 10 minutes and air cooling to room temperature.

Cool to -100°F and hold 8 hours

Precipitation harden at 950°F for 1 hour and air cool

#### PH 15-7 Mo TH 1050

Destabilize by heating to 1400°F, holding 90 minutes and air cooling to room temperature
Cool to 55°F within one hour of the destabilization and hold
30 minutes

Precipitation harden at 1050°F for 90 minutes and air cool

Following heat treatment the specimens were machined to finished dimensions and polished to remove machining marks and transverse scratches. The final polishing was done in the longitudinal direction using wet 600 grit silicon carbide paper.

#### 2. Forging Specimens

Longitudinal and transverse specimens were cut from the four inch square forged billets according to the approved layout. The rough cut pieces were identified and heat treated using the cycles shown for the sheet specimens. All machining was performed after heat treatment. The specimens were polished as described for the sheet specimens.

#### 3. Specimen Configurations

Drawings of the sheet and forgings specimens are shown in Figures 1 and 2.

#### D. <u>Test Procedures</u>

#### l. Tensile Tests

Tensile tests for sheet and forging specimens were performed in accordance with ASTM Standard E8. Unnotched specimens were tested at room and applicable elevated temperatures listed in Table III. Both longitudinal and transverse directional specimens were tested for each condition. Notched specimens were tested at room temperature to determine notch strengths for use in conjunction with fatigue tests.

The tensile tests were run on Tinius Olsen Universal Testing Machines employing a uniform loading rate of 0,005 inches per inch per minute for the unnotched specimens and 65,000 psi per minute for the notched specimens. Tinius Olsen "S" type extensometers which exceed the requirements of ASTM Class B-1 were used for determining the 0,2 percent offset yield strength of unnotched specimens. This method is in accordance with ASTM Standard designation A370-61T.

Automatically controlled infra red furnaces were used for the elevated temperature testing. A minimum of two thermocouples were attached to each test specimen for all high temperature tests.

#### 2. Axial Load Fatigue Tests

These tests were run on notched and unnotched specimens at room and applicable elevated temperatures listed in Table IV. Sheet specimens were machined in the longitudinal direction. The tests were conducted using stress ratios (A) of infinity (forgings only), 0.98, and 0.50 where:

A = Alternating Stress
Mean Stress

#### D. Test Procedures (continued)

Stress levels were selected to produce fatigue life from 1,000 to 10,000,000 cycles. The tests were conducted on the following type of fatigue machines:

Manufacturer	Type	Range Cycles/Minute
Krouse	Tension	1050/1650
Ivy (Baldwin)	Tension	1200
Sonntag	Tension	1800
Amsler Vibraphore	Tension	3500/4300
-	Compression	

Automatically controlled resistance-wound and infrared furnaces were used for the elevated temperature tests. A minimum of two thermocouples were attached to each test specimen for all tests. Temperatures were monitored at regular intervals throughout the tests by means of a direct reading potentiometer.

Two representative test set-ups are shown in Figures 3 and 4. One program stipulation was that no elevated temperature tests could be run at above 3600 cycles per minute at any "A" ratio other than infinity. This was inadvertently violated on a few curves early in the program by running at 4300 cycles per minute. Later in the program two of these curves were partially rerun at 1800 cycles per minute to determine the influence, if any, of frequency on the fatigue performance.

#### 3. Stress Rupture Tests

Stress rupture tests were conducted at the applicable elevated temperature as listed for the fatigue tests as shown in Table IV. These tests were run to provide the stress rupture to complement the fatigue tests in establishing constant life.

Stress rupture tests were run on Satec Stress Rupture Machines. These machines employ a lever arm that has a ratio of 20:1. Load is applied by dead weights which provided a constant stress.

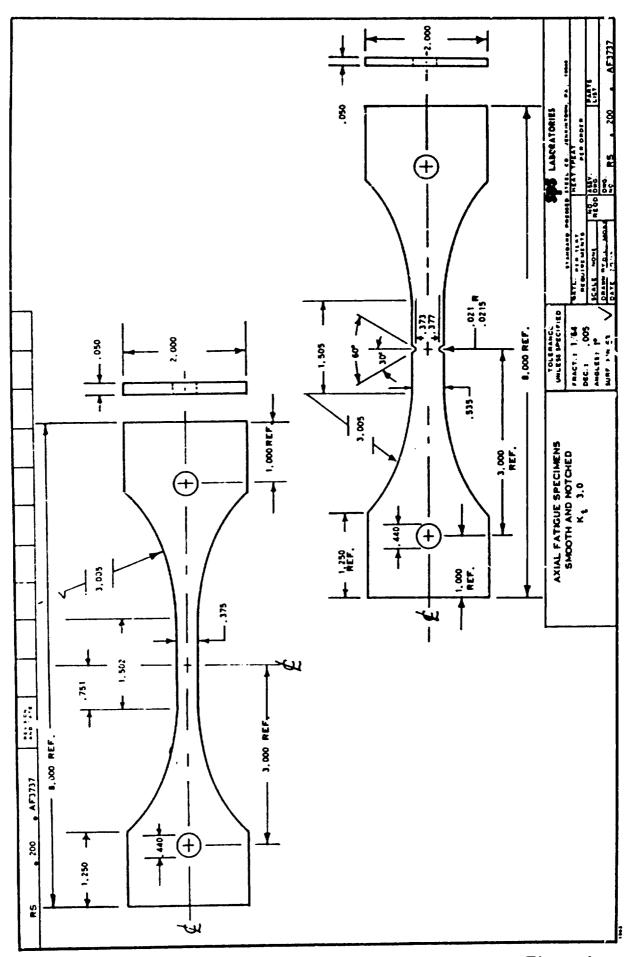


Figure 1

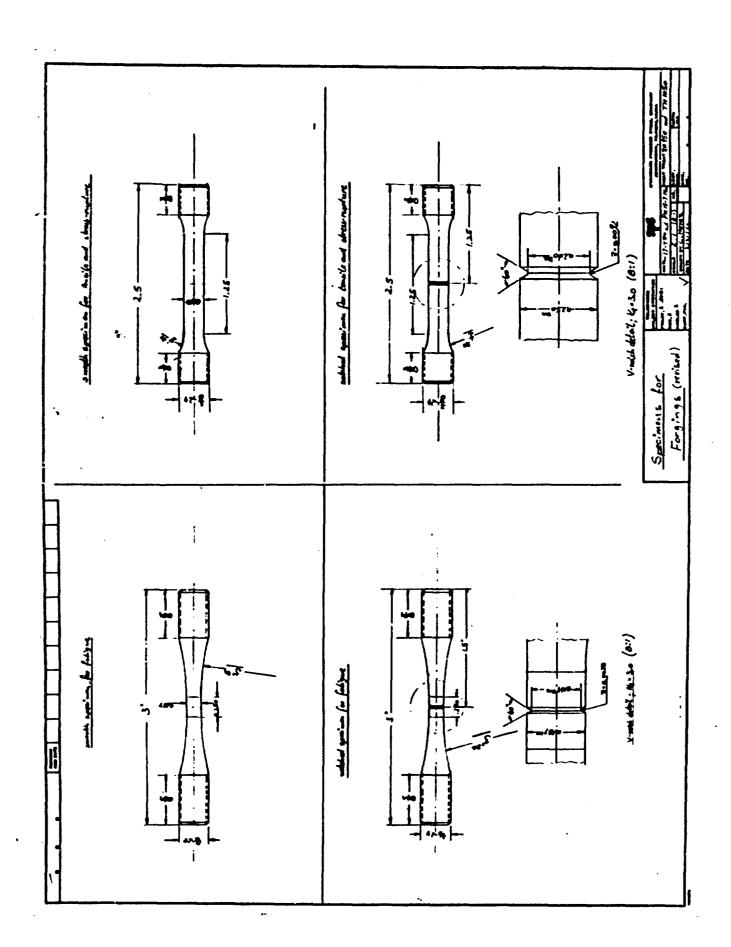


Figure 2

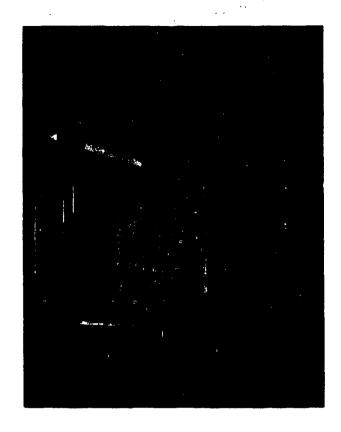


Figure 3. Elevated temperature fatigue test on sheet specimen in Amsler Vibraphore.



Figure 4. Elevated temperature fatigue test on sheet specimens in Sonntag Machine.

#### SECTION III

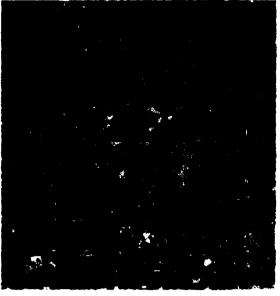
#### **METALLOGRAPHY**

Specimens of all materials were mounted and examined metallographically. Transverse and longitudinal photomicrographs of all materials are shown in Figures 5 through 30.



Transverse

Figure 5. AM 350 sheet, asreceived



Longitudinal
Figure 6. AM 350 sheet, asreceived.

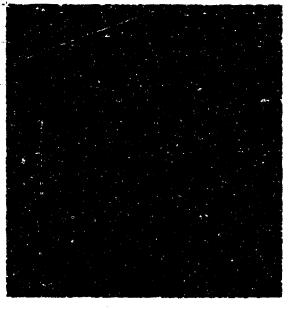


Transverse
Figure 7. AM 350 SCT sheet

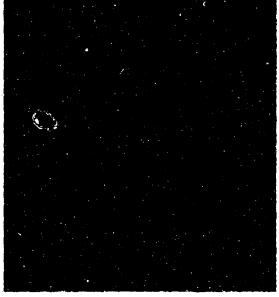


Longitudinal
Figure 8. AM 350 SCT sheet

Etchant: Mixture of picric, nitric, and hydrochloric acids



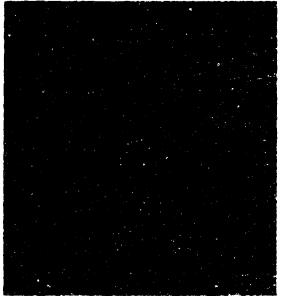
Transverse
Figure 9. 17-7 PH sheet, as-received.



Longitudinal
Figure 10. 17-7 PH sheet, as-received.

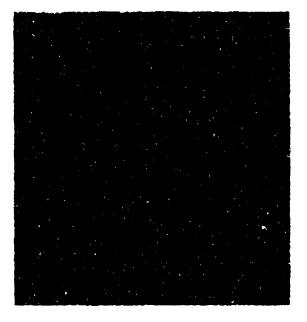


Transverse
Figure 11. 17-7 PH RH 950 sheet.



Longitudinal
Figure 12. 17-7 PH RH 950 sheet.

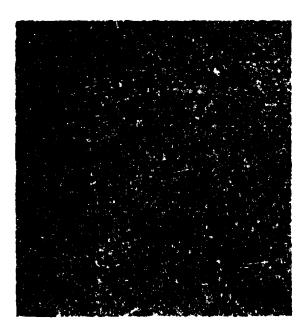
Etchant: Mixture of picric, nitric, and hydrochloric acids



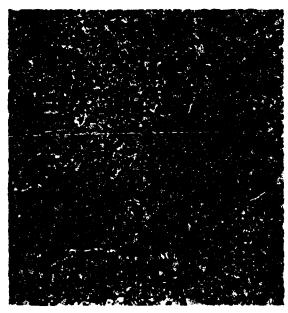
Transverse
Figure 13. PH 15-7 Mo sheet
as-received.



Longitudinal
Figure 14. PH 15-7 Mo sheet
as-received.

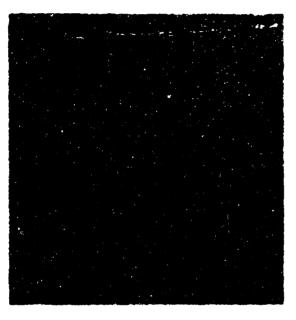


Transverse
Figure 15. PH 15-7 Mo RH 950
Sheet



Longitudinal
Figure 16. PH 15-7 Mo RH 950
Sheet

Etchant: Mixture of picric, nitric, and hydrochloric acids





Transverse Figure 17. PH 15-7 Mo TH 1050 Sheet

Longitudinal Figure 18. PH 15-7 Mo TH 1050 Sheet

Magnification: X500
Etchant: Mixture of picric, nitric and hydrochloric acids.



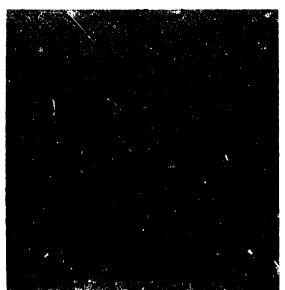
Transverse
Figure 19. 17-7 PH Forging, asreceived.



Longitudinal
Figure 20. 17-7 PH Forging, asreceived.



Transverse Figure 21, 17-7 PH RH 950 forging



Longitudinal
Figure 22. 17-7 PH RH 950 forging

Etchant: Mixture of picric, nitric, and hydrochloric acids.

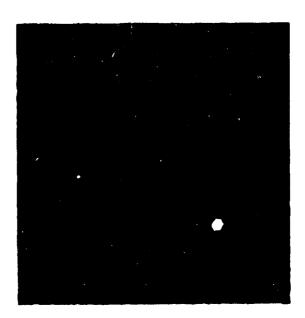


Transverse Figure 23. 17-7 PH TH 1050 forging Figure 24. 17-7 PH TH 1050 forging

Longitudinal

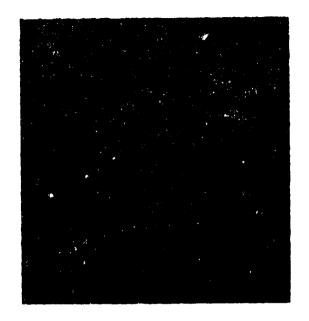


Transverse Figure 25. PH 15-7 Mo forging asreceived.

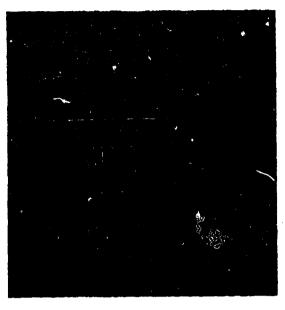


Longitudinal Figure 26. PH 1507 Mo forging asreceived.

Etchant: Mixture of picric, nitric, and hydrochloric acids.



Transverse
Figure 27. PH 15-7 Mo RH 950
forging.



Longitudinal
Figure 28. PH 15-7 Mo RH 950 forging.



Transverse
Figure 29. PH 15-7 Mo TH 1050 forging.



Longitudinal
Figure 30. PH 15-7 Mo TH 1050 forging.

Etchant: Mixture of picric, nitric, and hydrochloric acids.

#### SECTION IV

#### **DISCUSSION**

#### A. Variation of Fatigue Life with Test Frequency

It has been mentioned in Section IID that a few elevated temperature S-N curves were inadvertently run at 4300 cycles per minute at ratios of .5 and .98. This frequency being above the 3600 cycles per minute maximum stipulated by the contract, it was decided that we would partially rerun two of these curves to determine if the 4300 cycles per minute lata is valid. The curves thus checked are the .5 A ratio curves in Figures C7 and C8 and the rerun points are indicated as having been run at 1800 cycles per minute. It is obvious from these curves that the effect of a frequency change from 4300 to 1800 cycles per minute does not significantly alter the shape of the S-N curve under the above conditions.

#### B. Effect of Temperature on Fatigue Life

The change in shape and position of the S-N curves between room temperature and an intermediate temperature (such as in this case 600°F) has been discussed at great length in previous Mil Handbook 5 data generation reports such as AFML-TR-69-12, Fatigue, Creep, and Stress-Rupture Properties of Several Super Alloys by Blatherwick and Cers of the University of Wisconsin. This characteristic behavior is again in evidence in the results of this program. The effect is one of producing a 10<sup>7</sup> stress level at 600°F which is higher than the 10<sup>7</sup> stress level at room temperature. Generally the 10<sup>5</sup> stress level at 600°F is lower than the room temperature 10<sup>5</sup> stress level. Examination of the data in all places where a room temperature vs 600°F comparison is possible reveals that in 14 of 21 cases the 600°F -10<sup>7</sup> stress level is higher than the room temperature -10<sup>7</sup> stress level. Of the other 7, three are equal and four decrease a maximum of 5 KSI from room temperature to 600°F.

Of the fourteen cases where an increase occurs, one is worthy of further note. This is the 17-7 PH RH 950 forging, notched, .5 A ratio. The 10<sup>7</sup> stress level increases from 45 KSI to 90 KSI with the temperature change from room to 600°F. This behavior is readily explained by reference to Table BI where it can be seen that the notched/smooth tensile ratio goes from 0.78 (166/213) at room temperature to 1.25 (227/181) at 600°F.

#### SECTION V

#### RESULTS

This section contains the results of all tests performed under this contract.

The results are collected in sections according to material-formheat treat combinations involved.

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D-PH-15-7 Mo RH 950 Sheet	83
E-PH 15-7 Mo RH 950 Forging	101
F-PH 15-7 Mo TH 1050 Sheet	121
G-PH 15-7 Mo TH 1050 Forging	137

The tables and figures are listed on the first page of each section.

#### SECTION VA

# 17-7 PH RH 950 SHEET

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TABLE AI

TENSILE TEST DATA FOR 17-7 PH, RH950 SHEET MATERIAL. 050 THICK

				SMOOTH			NOTCHE	NOTCHED - 3.0 K <sub>t</sub>
Test	Specimen	Spec.	Ult. Tensile Strength,	0, 2% Offset Yield Str. Ksi	Elongation in 2",	Tensile Modulus (E) 10 <sup>6</sup> psi	Spec. No.	Ultimate Tensile Strength, Ksi
Room	1	PB-1 PB-11 PB-11	213, 5 212, 3 218, 3	189, 2 186, 8 199, 6	11. 5 12. 5 10. 5	30, 4 30, 4 30, 0	QC1 QC2 QC3	241. 2 237. 3 248. 4 242. 3
	T	SC-43 SC-44 TB-28	218. 6 217. 1 219. 8 218. 5	201, 3 199, 4 201, 6 204, 1	8.0 7.0 6.5	31.9 31.8 31.3 31.7	UC-10 UC-11 UC-12	245. 0 242. 5 245. 0 244. 2
600° F	1	PB-2 PB-3 PB-4	186. i 186. 3 180. 3 184. 2	136, 4 144, 2 133, 3 137, 9	7.0 6.5 9.0		QC-4 QC-5 QC-6	202. 6 204. 0 200. 8 202. 5
	Ħ	UC-8 UC-9 UC-20	188. 1 179. 7 180. 8 182. 9	132, 7 134, 5 135, 7 134, 3	7.0 5.5 6.0 6.2		TB-12 TB-13 TB-23	210, 2 210, 5 205, 6 208, 8
800°F	J.	PB-5 PB-6 PB-7	158.9 158.7 156.4 158.2	119.7 119.1 120.5 119.8	10, 5 13, 0 8, 0 10, 5		00-7 00-8 00-9	181, 4 183, 6 176, 0 180, 3
	<b>(-</b> 1	TB-25 TB-26 TB-27	162, 7 163, 7 162, 1 162, 8	127. 0 128. 5 129. 4 128. 3	9.5 11.5 8.0 9.7		TB-24 TB-16 TB-33	189. 2 183. 8 178. 7 183. 9

TABLE AII

STRESS RUPTURE TEST DATA FOR 17-7 PH, RH 950 SHEET MATERIAL .050 INCHES THICK - TRANSVERSE

Spec. No.	Kt	Test Temp.	Stress ksi	Life Hrs.
SC-33 SC-37 SC-36 SC-35 SC-34	1.0	600°F	185 180 175 160 130	<0. 05 19. 1 152. 1 200. 0+ 190. 3+
SC-41 SC-42 SC-40 SC-39 SC-38	1.0	800°F	110 106 100 80 60	5, 5 136, 6 191, 7 207, 4+ 187, 0+
TB-42 TB-40 UC-31 UC-32 TB-20	3, 0	600°F	200 196. 0 194. 0 192. 0 190. 0	<0. 05 51. 9 72. 1 37. 2 211. 1+
TB-46 TB-47 TB-49 TB-48 TB-45	3, 0	800°F	140. 0 130. 0 127. 0 120. 0 110. 0	15, 8 92, 3 169, 6 266, 8+ 189, 3+

#### 17-7 PH RH 950 SHEET STRESS VS. TIME TO RUPTURE

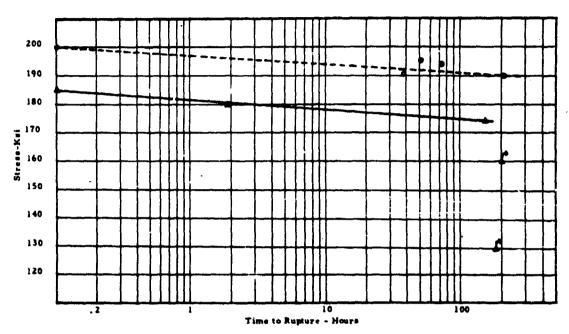


Figure Al-600°F

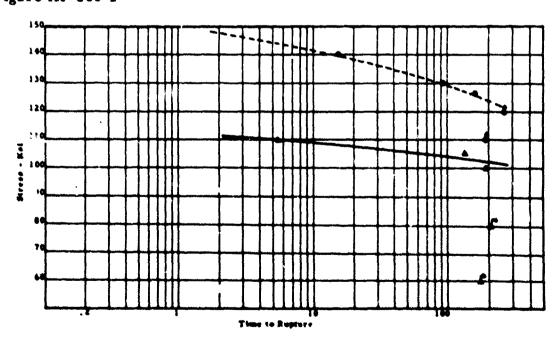


Figure A2-800°F

#### TABLE AIII

# FATIGUE TEST DATA

Material- 17-7 PH RH 950 Sheet
Type of Specimen- Transverse Smooth
Test Temperature- Room

Test Frequency-Cycles/minute A=. 98-1050 A=. 50-1050

Specimen No.	"A" Ratio	Applied Stress, ksi			Life,
		Sm	Sa	Sc	Kilocycles
C-20-II C-21 C-22 C-19 C-23 C-27 C-18 C-24 C-25 C-26	. 98	54. 6 58. 6 59. 8 62. 2 62. 4 65. 1 69. 0 73. 6 77. 1 84. 3	53.5 57.5 58.6 60.9 61.1 63.8 67.6 72.1 75.6 82.6	108. 1 116. 1 118. 3 123. 1 123. 5 128. 9 136. 5 145. 7 152. 7 166. 9	10,537.0+ 8,371.0 8,212.0 382.0 2,524.0 463.0 151.0 233.0 41.0 28.0
RB42 RB41 SC-8 SC-5 SC-9 SC-1 SC-3 SC-4 SC-6	.50	59. 5 79. 3 87. 4 87. 4 87. 4 91. 2 95. 3 99. 2 107. 1	29.7 39.6 43.6 43.6 43.6 45.7 47.6 49.6 53.6	89.3 119.0 131.0 131.0 136.9 142.9 148.8 160.7	10, 241. 0+ 10, 134. 0+ 16, 000. 0+ 10, 030. 0+ 147. 0 257. 0 254. 0 174. 0 61. 0

#### TABLE AIV

### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Sheet Type of Specimen- Transverse Smooth Test Temperature-600°F Test Frequency- Cycles/minute
A=.98-3600
A=.5-3600

Specimen No.	"A"	Applied Stress, ksi			Life,
	Ratio	Sm	Sa	Sc	Kilocycles
RB-32	. 98	58. 1	56. 9	115.0	10,000.0+
RB-31		60.6	59.4	120.0	6, 296. 0
RB-30	Ī	63, 1	61.9	125.0	4, 268. 0
RB-29		65.7	64. 4	130.0	115,0
RB-28	1	68. 2	66.8	135.0	33.0
RB-26		70.7	69.3	140.0	34.0
RB-23	Ì	70.7	69. 3	140.0	27.0
RB-6	Ì	73. 2	71.8	145.0	68.0
RB-4		75.8	74.3	150.0	25. 0
RB-3	. 5	100, 0	50, 0	150.0	10, 090, 0+
RB-7		103.4	51.6	155.0	68.0
RB-Z		103, 4	51.6	155.0	35.0
RB-9	1	106,7	53, 3	160.0	105.0
RB-5	1	106.7	53.3	160.0	64.0
SC-32	1	106.7	53.3	160.0	15,0
RB-8	Ī	110,1	55.0	165.0	152.0
RB-10	İ	110.1	55.0	165.0	36.0
RB-11	1	113.4	56.6	170.0	36.0

TABLE AV

#### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Sheet
Type of Specimen- Transverse Smooth
Test Temperature- 800°F

Test Frequency- Cycles/minute A= .98-3600 A= .5 - 3600

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
SC-29.	. 98	55.6	54, 5	110.0	14, 380. 0+
SC-29		58.1	56.9	115.0	5, 330, 0
SC-27	1	60, 3	58, 2	117.5	48.0
SC-26	i	60.6	59.4	120.0	3, 472. 0
SC-25		63.7	62.5	122.5	2,731.0
SC-20		63, 1	61.9	125.0	2, 567. 0
SC-30		65.7	64.4	130.0	63.0
RB-46		65.7	64, 4	130.0	53.0
SC-31		68.2	66.8	135.0	14.0
SC-11	. 5	83, 4	41.6	125.0	10, 133, 0+
SC-16		86.7	43, 3	130.0	10,982.0+
SC-12	·	90.1	45.0	135.0	3, 477. 0
SC-13		90.1	45, 0	135.0	214.5
SC-14		93.3	46.6	140.0	186.0
SC-15		96.7	48, 3	145.0	332.0
SC-17		100.0	50.0	150.0	2, 188. 0
SC-19		100.0	50.0	150.0	1,701.0
SC-18		103.3	51,6	155.0	15.0

#### TABLE AVI

#### FATIGUE TEST DATA

Material - 17-7 PH RH 950 Sheet Type of Specimen - Transverse Notched Test Temperature - Room Test Frequency-Cycles/minute
A = .98-1050

A = .50-1050

Specimen	"A"	Appli	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles
TB-37	. 98	23.9	23.5	47.4	14,209.0+
TB-36		26.0	25, 4	51.4	10,315.0+
TB-3		27.2	26.7	53.9	794.0
TB-17	}	28.0	27.4	55.4	4,838.0
TB-35		28.0	27.4	55.4	591.0
TB-II		28.8	28. 4	57. 2	132.0
UC-4		31.7	31.0	62.7	426.0
UC-3	l I	36.0	35, 2	71,2	106.0
υC-7	ļ	39.8	39, 0	78.8	32.0
UC-21	1	39.8	39.0	78,8	6.0
TB-I		43.7	42.7	86.4	3.0
UC-28	.50	31.8	15.9	47.7	10,860.0+
UC-30	İ	40, 2	20.1	60.3	11,249.0+
UC-23	i I	40, 2	20, 1	60.3	1,063.0
TB-1		41.7	20.9	62.6	1,200.0
UC-1		43.6	21.8	65.4	117.0
TB-32		<b>4</b> 8.0	24, 0	72.0	194.0
UC-2		<del>4</del> 8.0	24, 0	72.0	98.0
TB-31		52,0	26.0	<b>78.</b> 0	170.0
TB-15		52,3	26.2	<b>78.</b> 5	142.0
UC-25	, ,	59, 5	29, 8	89, 3	8,0

#### TABLE AVII

#### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Sheet
Type of Specimen- Transverse Notched
Test Temperature-600°F

Test Frequency-Cycles/minute A=. 98-3600 A=. 5 - 3600

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
ŪC-39	. 98	25, 3	24.8	50.0	10,000.0+
UC-38		25.3	24,8	50.0	127.0
UC-37		25.3	24.8	50,0	44.0
UC-36		27.8	27.2	55.0	5, 350, 0
UC-40		27,8	27.2	<b>55.</b> 0	40.0
UC-42		27.8	27.2	5 <b>5.</b> 0	33.0
UC-33		30.3	29.7	60.0	459.0
UC-41		30.3	29.7	60.0	17.0
UC-35		31.3	30.9	62.5	17.0
UC-34		32.8	32. 2	65.0	16, 0
UC-44		32,8	32, 2	65.0	18,0
UC-43		35.4	35, 4	70.0	11.0
UC-48	. 5	36, 7	18, 3	55, 0	18,696.0+
SC-47		40.0	20.0	60.0	490.0
UC-47		40.0	20.0	60.0	470,0
SC-46		40.0	20.0	60.0	47.0
UC-46		43.4	21,7	65.0	62.0
SC-45		43, 4	21.7	65.0	56.0
UC-49		46.7	23.3	70.0	20,0
UC-45	<u> </u>	46.7	23, 3	70,0	7.0

#### TABLE AVIII

#### FATIGUE TEST DATA

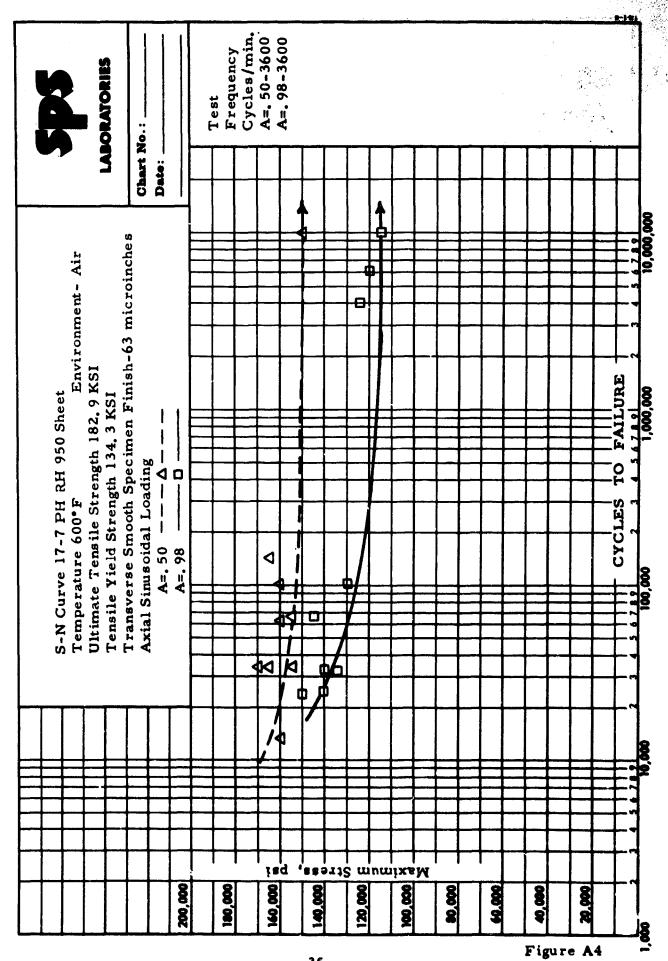
Material-17-7 PH RH 950 Sheet Type of Specimen- Transverse Notched Test Temperature-800°F

Test Frequency- Cycles/minute A= .98-3600

A = .5 - 3600

Specimen	"A"	Appli	ed Stress	, ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
UC-39 UC-48 TB-44 TB-8 TB-7 TB-6 TB-5 TB-4 SC-49 SC-48	. 98	22.7 22.7 25.3 27.8 27.8 30.3 32.8 35.4 37.9 40.4	22. 3 22. 3 24. 8 27. 2 27. 2 29. 7 32. 2 34. 7 37. 1 39. 6	45. 0 45. 0 50. 0 55. 0 60. 0 65. 0 70. 0 75. 0 80. 0	10,000.0+ 2,801.0 1,969.0 7,203.0 121.0 312.0 27.0 11.0 7.0 4.0
TB-34 TB-41 TB-29 TB-18 TB-10 TB-9 TB-43	. 5	40.0 43.4 43.4 46.7 50.0 53.4 56.7	20. 0 21. 7 21. 7 23. 3 25. 0 26. 6 28. 3	60.0 65.0 65.0 70.0 75.0 80.0	27, 324, 0+ 1, 002, 0 73, 0 89, 0 35, 0 20, 0 12, 0

SACATORIES	Chart No.:	÷ c	Frequency	Cycles/minute	A = .50-1050 A = .98-1050												
eet Environment-Air si Finiah 63 Microinches	:																2 3 4 5 6 7 8 9
	<i>_</i> 7 F					/ / A										CYCLES TO FAILURE	4
S-N Curve - 17-7 PH RH 950 S  Temperature-Room Ultimate Tensile Strength-218  Tensile Yield Strength-204 ksi  Transverse, Smooth Specimen	Axial Sinusoidal Loading A = .50 -																2 3 4 5 6 7 8 9
		200,000	180,000	980 991	ISc	140,000	750,000 PZ	Ls	100,000 X	WI	X Y 000 04	W	900.09	70,000	20,000		2 3 4 5 6 78 9



Frequency Cycles/min. A=. 50-3600 A=. 98-3600 LABORATORIES Test Chart No.: Date: Transverse Smooth Specimen Finish - 63 microinches Environment-Air 哥 4 Ultimate Tensile Strength 162,8 KSI FAILURE S-N Curve- 17-7 PH RH 950 Sheet Tensile Yield Strength 128, 3 KSI A=. 50 - - - A - - -Axial Sinusoidal Loading JO 0 Temperature- 800°F CYCLES A=. 98 ieq 120,000 20,000 80,000 900,000 40,000 760,000 **69.000** Figure A5

ST ST ST ST ST ST ST ST ST ST ST ST ST S	Chart No.:	Frequency Cycles/min.	A=. 50-3600 A=. 98-3600	T				T			
S-N Curve-17-7 PH RH 950 Sheet Temperature 600°F Ultimate Tensile Strength 208, 8 KSI Transverse Notched Specimen Finish- 63 microinches											CYCLES TO FAILURE 15 67 89
				l de l	*880		umixel	3			
		8	26.88	38	120,080	8 8	88 08 88 08	88 99	8 9 Figu	88 8 8	,

Frequency Cycles/min. A=. 50-3600 A=, 98-3600 LABORATORIE Test Chart No.: \_ Date: Transverse, Notched Specimen Finish - 63 microinches Temperature 800°F Environment- Air Ultimate Tensile Strength 183, 9 KSI TO FAILURE S-N Curve 17-7 PH RH 950 Sheet Kt = 3.0 Axial Sinusoidal Loading A=. 50 ---Δ-þ CYCLES A=. 98 Figure A8

0. 1.1 0. 8 0, 25 Ultimate Tensile Strength-Smooth 218 ksi, Notched 244 ksi Smooth Notched 0.43 CONSTANT LIFE DIAGRAM - 17-7 PH RH 950 Sheet 67 Tensile Yield Strength - Smooth 204 ksi Specimen Finish - 63 microinches Axial Sinusoidal Loading Temperature - Room 2.5 Environment - Air 2, 33 0.0 320 280 240 350 A= 8 Figure A9 esert& mumixsM

Minimum Stress, ksi

0, 11 0, 8 0, 25 0, 6 Ultimate Tensile Strength- Smooth 182 KSI, Notched 208 KSI Notched Smooth CONSTANT LIFE DIAGRAM- 17-7 PH RH 950 SHEET \_\_ 67 0, 2 Tensile Yield Strength-Smooth 134 KSI Specimen Finish- 63 microinches Axial Sinusoidal Loading Temperature- 600°F Environment- Air 2, 33 9.0

180

A= 8

R = -1

160

100

Maximum Stre

100

9

Minimum Stress, ksi

-40

-60

9 8 Figure Al 0 180-160 -140 -120 -100 -80

100 120 140 160 180 0.11 0, 25 0, 6 Ultimate Tensile Strength- Smooth 162 KSI, Notched 183 KSI Notched Smooth CONSTANT LIFE DIAGRAM- 17-7 PH RH 950 SHEET 0.43 9 79-Tensile Yield Strength-Smooth 128 KSI Minimum Stress, ksi Specimen Finish - 63 microinches Axial Sinusoidal Loading Temperature-800°F -60 -40 Environment- Air ռունուկումումումույ -180-160 -140 -120 -100 -80 0.6 160 100 Figure All Maximum Stress,

## SECTION VB

## 17-7 PH RH 950 FORGING

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TABLE BI

TENSILE TEST DATA FOR 17-7 PH RH 950 FORGING MATERIAL

						<del></del>	
Notched - 3, 0 Kt	Ultimate Tensile Strength, ksi	155.7 163.1 177.6 165.5	102.8 117.8 156.8 125.8	224. 0 228. 0 228. 3 226. 8	216.7 156.0 155.6 176.1	219. 0 207. 1 204. 5 210. 2	173.9 159.9 195.6 176.5
Notc	Spec. No.	E 3	L1 K1 K7	E5 E6	L2 K3 K4	E7 E8 E9	L3 K5 K6
	Tensile Modulus 10 <sup>6</sup> psi	28. 7 29. 6 29. 7 29. 3	28. 4 29. 2 29. 4 29. 0		1		
	Reduction of Area %	6. 1	0,5	42. 1 42. 2 36. 6 40. 3	6. 1 14. 6 13. 9 11. 5	51.1 52.6 51.6 51.8	3. 2 3. 9 3. 9
	Elongation in 2", %	6.0 - 1.0	2. 0 3. 0	13.0 13.0 11.0 12.3	7.0 7.0 6.0 6.7	15.0 16.0 15.0	2. 0 2. 0 2. 0
Smooth	0.2% Offset Yield Str., ksi	192. 9 169. 8 197. 5 186. 7	_(1) _(1) _(1)	149, 1 145, 4 135, 2 143, 2	144.8 137.7 140.8 141.1	131. 6 132. 6 126. 0 130. 1	110. 5 117. 3 122. 4 116. 7
	Ult, Tensile Strength, ksi	218, 4 207, 4 214, 0 213, 3	146. 9 114. 3 146. 9 136. 0	184, 1 180, 6 178, 5 181, 1	179, 5 177, 5 177, 5 178, 2	158.4 157.1 154.3 156.6	133.8 141.8 146.9 140.8
	Spec. No.	D45 D46 D47	L-5 L-6 M-2	E22 E23 E24	M1 N1 N2	D49 X-1 X-3	M-3 M-5 M-6
	Spec imen Or ientation	I.	Η	L	Ţ	ı	H
	Test Temp.	Room		600°F		800° F	

(1) Brittle fracture, no yield

TABLE BII

# STRESS RUPTURE DATA FOR 17-7 PH, RH 950 FORGING MATERIAL - LONGITUDINAL

Spec. No.	Kţ	Test Temp.	Stress ksi	Life Hours
E26 D44 X1 X2 D46	1.0	600°F	200. 0 175. 0 171. 0 166. 0 160. 0	< 0.05 2.8 9.6 156.6 519.7+
E27 E28 E29 D45 D49	1.0	800°F	150. 0 130. 0 110. 0 105. 0 97. 0	<0.05 2.2 119.4 132.3 202.7+
E20 E21 E14 E12 E10	3.0	600°F	233. 0 229. 0 225. 0 220. 0 204. 0	<0, 05 161, 3 243, 0+ 461, 0+ 328, 9+
E15 E16 E17 E18 E19	3, 0	800°F	190. 0 185. 0 165. 0 155. 0 142. 0	1.1 1.6 38.0 49.3 195.4

17-7 PH RH 950 FORGING STRESS VS. TIME TO RUPTURE

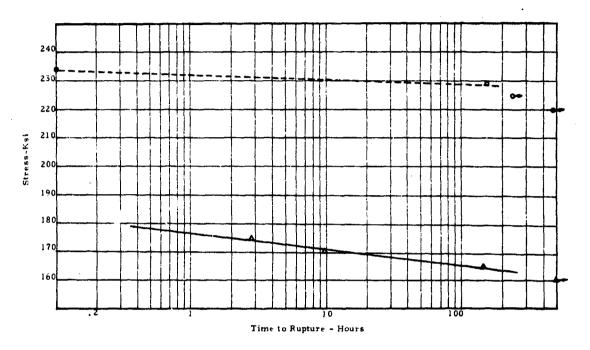


Figure B1-600°F

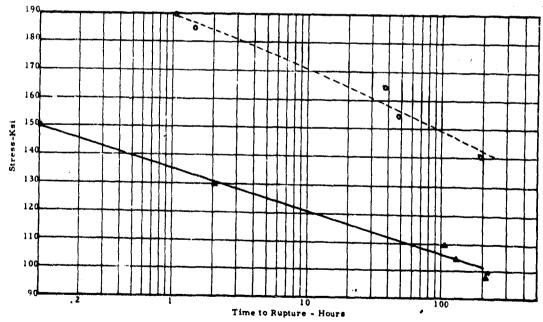


Figure B2-800°F

#### TABLE BIII

## FATIGUE TEST DATA

Material- 17-7 PH RH 950 Forging
Type of Specimen- Longitudinal - Smooth
Test Temperature-Room

Test Frequency - Cycles/Minute  $A = \infty - 4300$  A = .98 - 4300A = .50 - 1050

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
C7 C10 C29 C30 C11 C8 C14 C15 C28 C13	Infinity	0	50. 0 75. 0 75. 0 80. 0 80. 0 85. 0 90. 0 100. 0 110. 0	50. 0 75. 0 75. 0 80. 0 80. 0 85. 0 90. 0 100. 0 110. 0	10,702.0+ 10,679.0+ 10,045.0+ 10,184.0+ 1,435.0 1,364.0 1,021.0 378.0 91.0
G-20-III G-21-II G-22-II G-23-II G-19-II G-27-II G-18-II G-24-II G-24-II G-26-II	0. 98	54.6 58.6 59.8 62.4 62.2 65.1 69.0 73.6 77.1	53.5 57.5 58.6 61.1 60.9 63.8 67.6 72.1 75.6 82.6	108.1 116.1 118.4 123.5 123.1 128.9 136.6 145.7 152.7 166.9	10,537.0+ 8,371.0 8,212.0 2,524.0 382.0 463.0 151.0 233.0 41.0 28.0
C-17-II C-16-II C-2-II C-3-II C-5-II C-1-II C-6-II C-12-II C-9-II	0.5	92. 3 94. 4 103. 4 106. 6 106. 8 110. 2 113. 6 119. 9 120. 7	46. 1 47. 2 51. 7 53. 3 53. 4 55. 1 56. 8 59. 9 60. 3	138.4 141.6 155.0 159.9 160.3 165.3 170.4 179.8 181.0	10,130,0+ 7,729.0 4,497.0 283.0 309.0 668.0 84.0 90.0 145.0

#### TABLE BIV

#### FATIGUE TEST DATA

Material-17-7 PH RH 950 Forging

Type of Specimen-Longitudinal - Smooth Test Temperature-600°F

Test Frequency - Cycles/minute

A = - 4300

A = .98 - 4300

A = .50-4300

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
D5 D4	Infinity	0	85. 0 90. 0	85, 0 90, 0	10,000.0+ 5,942.0
D6			95.0	95. 0	2, 972, 0
D11			95. 0	95. 0	174.0
L 0			95.0	95, 0	52.0
D8			95, 0	95. 0	49.0
D7		·	97.5	97.5	4, 462. 0
D9			97.5	97.5	46.0
D3			100, 0	100,0	40. 0
C47	0. 98	63, 2	61.8	125. 0	10, 232, 0+
C46		63. 2	61.8	125.0	6, 266. 0
C44		65, 7	64. 3	130, 0	5, 199. 0
C45		682	66.8	135.0	3, 668. 0
′ 43		70, 7	69. 3	140.0	7, 145, 0
C48		70, 7	69.3	140.0	2,801.0
D,		73, 3	71.7	145.0	1,180.0
C49		75, 8	74, 2	150.0	66,0
D43		80,8	79. 2	160, 0	210
C41		80,8	79, 2	160, 0	16.0
C36	0, 5	96, 7	48, 3	145. 0	10,000.0+
C32		100.0	50, 0	150.0	7, 433. 0
C40		105.0	52, 5	157.5	3, 966. 0
C33		105.0	52. 5	157.5	1,061.0
C39	}	106.7	53, 3	160.0	3, 490. 0
C35		106.7	53, 3	160, 0	614.0
C34	1	110.0	55, 0	165. 0	70, 0
C31		110.0	55, 0	165, 0	42, 0
C38		113.4	56.7	170.0	40, 0
G37	1	113, 4	56.7	170. 0	24. 0
L	<u> </u>	L		<u> </u>	

TABLE BV

#### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Forging
Type of Specimen- Longitudinal - Smooth
Test Temperature-800°F

Test Frequency - Cycles/minute

A = - 4300

A = .98 - 1800

A = .50 - 4300

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
D35	Infinity	0	80.0	8Q 0	10,755,0+
D33			80.0	80,0	108, 0
D34			85. U	85, 0	3, 878, 0
D32			85.0	85, 0	2, 539, 0
D36			90.0	90,0	383, 0
D42	Į į		95.0	95, 0	64.0
D40		:	95.0	95, 0	28. 0
D37			105.0	105.0	15, 0
D41			105.0	105, 0	7, 0
D38			110.0	110.0	6.0
D28	0. 98	53 <b>,</b> 0 `	52, 0	105,0	10,042.0+
D27		55, 6	54, 4	1100	3, 726, 0
D31		55.6	54, 4	110.0	3, 401. 0
DZZ		56, 9	55, 7	112, 6	4, 828, 0
D29		58.1	56, 9	115.0	3, 206, 0
D26		58, 1	56. 9	115.0	62. 0
D30		60.6	59. 4	120, 0	685, 0
D25		60, 6	59, 4	120.0	19.0
D24		65.7	64, 3	130.0	18. 0
D23		75, 8	74, 2	150,0	6. 0
D15	0. 5	80, 0	40. 0	120, 0	10,000,0+
D19		81.7	40, 8	122, 5	2, 336. 0
DZO	İ	83, 3	41.7	125. 0	12, 032, 0+
D18		83, 3	41.7	125. 0	3, 833, 0
D17		83, 3	41.7	125, 0	794. 0
D16		86. 7	43, 3	130.0	5, 935. 0
D14		93.3	46.7	140.0	1,774.0
ובם ב		96. 7	48, 3	145.0	258. 0
D13		100.0	50,0	150.0	71.0
D12		103, 3	51.7	160. 0	29. 0

#### TABLE BVI

#### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Forging
Type of Specimen- Longitudinal Notched
Test Temperature- Room

Test Frequency-Cycles/minute
A= 00-4300
A= .98-1050
A= .5 -1050

Specimen	"A"	Appli	ed Stress,	ksi ·	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
A-15 A-12 B-42 A-14 A-17 B-43 A-18 A-13	Infinity	0	30.0 35.0 40.0 40.0 45.0 45.0 50.0	30. 0 35. 0 40. 0 40. 0 45. 0 50. 0	10,020,0+ 2,700,0 1,496.0 484.0 508.0 413.0 117.0 12.0
A-5-II A-8-II A-12-II A-11-II A-10-II A-7-II A-4-II A-2-II A-3-II A-9-II	0, 98	28. 0 30. 3 31. 6 31. 6 32. 7 35. 0 37. 3 46. 7 56. 2 65. 9	14.6 15.2 15.8 15.8 16.4 17.5 18.6 23.4 28.1	42. 0 45. 5 47. 4 47. 4 49. 1 52. 5 55. 9 70. 1 84. 3 98, 1	10, 015, 0+ 10, 155, 0+ 611, 0 391, 0 401, 0 145, 0 132, 0 81, 0 22, 0 8, 0
A-24-II A-22-II A-26-II A-25-II A-28-II A-29-II A-30-II A-20-II A-21-II A-19-II	0, 50	23. 4 28. 1 28. 1 32. 7 32. 7 37. 4 42. 1 46. 8 51. 4 60. 8	22. 9 27. 5 27. 5 32. 1 32. 1 36. 7 41. 3 45. 8 50. 4 59. 6	46.3 55.6 55.6 64.8 64.8 74.1 83.4 92.6 101.8 120.4	70,056.04 989.0 296.0 455.0 362.0 141.0 74.0 31.0

#### TABLE BVII

## FATIGUE TEST DATA

Material- 17-7 PH RH 950 Forging
Type of Specimen- Longitudinal - Notched
Test Temperature- 600°F

Test Frequency-Cycles/Minute

A = 99 - 4300

A = .98 - 1800

A = .50 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
A40 A41	Infinity	0	30.0	30.0	12,543,0+
A39	[		35.0 40.0	35.0 40.0	988. 0
A44			50.0	50.0	115.0 46.0
A38			60, 0	60.0	29. 0
A37			80.0	80.0	9. 0
A36			100.0	100.0	15. 0
A42			120.0	120.0	5. 0
A47	. 98	25. 2	24. 8	50.0	10,194.0+
A49		30.3	29.7	60.0	10,021.0+
Bl		32,8	32, 2	65.0	80.0
B5		35.4	34, 7	70.0	54, 0
B2		35,4	34, 7	70,0	22, 0
A48	1	37.9	37.1	75.0	46.0
B3		40,4	39.6	80.0	24, 0
B4		45.5	44.6	90.0	13, 0
A46		50,5	49.5	100.0	11.0
A45		90.9	89.1	180.0	1, 0
X34	. 50	60.0	30.0	90.0	10,005.0+
X23		60.0	30, 0	90.0	10,004.0+
X33		61.7	30, 8	92.5	35.0
X37		61.7	30.8	92.5	28.0
X24 X28		63.4	31.6	95.0	37.0
X26	Ì	63. 4 66. 7	31.6	95.0	25.0
X17		66.7	33, 3 33, 3	100.0 100.0	19.0
X25		70.0	35. 0	100.0	18.0 12.0
		, 0, 0	33.0	105.0	12.0

#### TABLE B VIII

#### FATIGUE TEST DATA

Material- 17-7 PH RH 950 Forging
Type of Specimen- Longitudinal Notched

Test Temperature- 800°F

Test Frequency-Cycles/Minute

 $A = \infty 4300$ 

A = .98-1800

A = .50-1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
B17	Infinity	0	30,0	30.0	10,000.0+
B15			40.0	40.0	151.0
B21			40.0	40.0	72.0
B14			50.0	50.0	46.0
B19			50.0	50, 0	21.0
B18			60.0	60.0	55.0
B20			60.0	60.0	11.0
B16			70.0	70.0	9.0
B13			100.0	100.0	5 ₩0
B12			180.0	180.0	1.0
B27	0, 98	20.2	19.8	40.0	10,000.0+
B28	- 7 / -	25.25	24.75	50.0	10,00G.0+
B31		27.8	27. 2	55.0	71.0
B26		30.3	29.7	60.0	310.0
B30		32.8	32, 18	65.0	27.0
B29		35.4	34.6	70.0	24.0
B25		40.4	39.6	80.0	14,0
B24		50.5	49.5	100.0	7.0
B23		60.6	59 <b>.</b> 4	120.0	4.0
B22		90.9	89.1	180.0	1, 0
B35	0.5	46.7	23.3	70.0	10,257.0+
B39		50.0	25.0	75. 0	10,277.0+
B38		50.0	25.0	75.0	3,268.0
B34		53.4	26.6	80.0	214.0
B41	}	53.4	26.6	80,0	41.0
B40		56.7	28.3	85.0	35.0
B37		60.0	30.0	90, 0	46.0
B33		66.7	33, 3	100,0	19.0
B36		73.4	36.6	110.0	11.0
B32		80.0	40.0	120.0	3.0
			<u> </u>		

LABORATORIES Chart No.:	Date:	Test Frequency -	Cycles/Minute A = .50 - 4300	A = .98 - 4300 A =					1				
PH PH 213 'Ksi en en	A=.98											CYCLES TO FAILURE	2 3 4 5 6 7 8 9 2 3 4 5 6 7 8 9 2 3 4 5 6 7 8 9 8 9 100,000,000 10,000,000 10,000,000
													10,000
												F	5 6 7
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SPS	Chart No.:	Test	Cycles/minute	A= 00-4300			4			
S-N Curve-17-7 PH RH 950 Forging  Temperature - 600°F  Ultimate Tensile Strength - 181 KSI  Tensile Yield Strength - 143 KSI  Longitudinal Smooth Specimen Finish - 63 Microinches	Axiai Sinusoidal Loading A=. 50 <b>A</b> A=. 98 A=. 98									2 3 4 5 6 7 8 9 CYCLES TO FAILURE
										3 4 5 6 78 9
++++	200,000	180,000	1. S	q s	20 00 17 17 17	96 8 MUN		40,000	20,000	B4

SPS LABORATORIES	Chart No.:		A = .50 - 4300 A = .98 - 1800 A = \infty - 4300						5 7 8 9
	Axiai Sim soldai Loading A = .50 A = .98	1			7				2 3 4 5 6 7 8 9 2 3 4 5 6 7 8 9 2 3 4 5 6 7 8
					9/				5 6 7 8 9
		180,000	1.2.4	, SSERT	S WOW	8 8 XAM	000'09	20,000	e B5

Cycles/minute A=, 50-1050 A=. 98-1050  $A = \infty - 4300$ Frequency LABORATORIES Test Chart No.: Date: Longitudinal, Notched Specimen Finish-63 Microinches S-N Curve 17-7 PH RH 950 Forging
Environment-Air FAILURE Ultimate Tensile Strength-165 KSI φφ TO Axial Sinusoidal Loading CYCLES A=. 50 A=. 98  $K_t = 3.0$ ınnınixsM ieq I , see x12 80,000 160,000 140,000 120,000 100,000 180,000 60,000 40,000 20,000 200,000 Figure B6 57

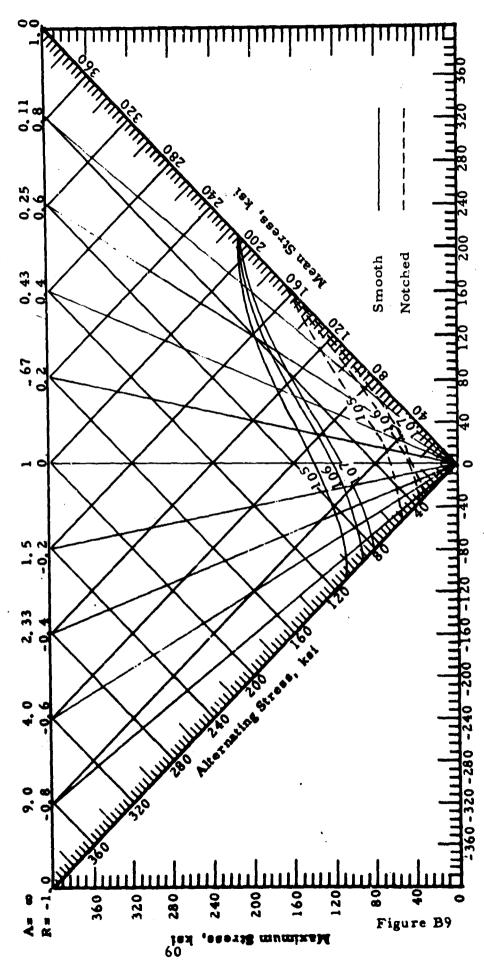
Cycles/Minute A = .50A = .98-1800Frequency -LABORATORIES Test Chart No .: \_ Date: \_\_ 10,000,000 Longitudinal Notched Specimen Finish - 63 Microinches Environment - Air TO FAILURE S-N Curve -17-7 PH RH 950 Forging 1,000,000 Ultimate Tensile Strength-227 Ksi 4 K<sub>t</sub>=3.0 Axial Sinusoidal Loading Temperature - 600°F CYCLES A = .50A = .98A = 00 160,000 . Ф 200,000 180,000 60,000 40,000 20,000

					200,000		180,000	IS	160,000		140.000 1 A J		120,000 M	MI	000,000 X	W	90,000		60,000		40,000		20,000	re	-7
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Ultimate Tensile Strength - Smooth - 213 KSI -- Notched (Kt=3.0)-166 KSI CONSTANT LIFE DIAGRAM - 17-7 PH RH 950 FORGING Tensile Yield Strength - Smooth 187 KSI Temperature - Room

Axial Sinusoidal Loading

Environment - Air Specimen Finish - 63 Microinches



Minimum Stress, ksi

80 100 120 140 160 180 ավառևահակակա 0.11 Ultimate Tensile Strength - Smooth - 181 Ksi -- Notched (Kt=3.0)-227 Ksi 0, 25 0, 6 Notched 0,43 Smooth .67 Minimum Stress, kst Tensile Yield Strength - Smooth - 143 Ksi 10% Specimen Finish - 63 Microinches -180-160 -140 -120 -100 -80 -60 -40 -20 2.5 Axial Sinusoidal Loading **Emlanhadadunlanlan** Environment - Air 2, 33 0.4 9.0 160 180 A= 8 R= -1 Figure Bl0 161 61

CONSTANT LIFE DIAGRAM -17-7 PH RH 950 FORGING

Temperature - 600°F

0, 25 0.43 . 67 Minimum Stress, kei Tensile Yield Strength - Smooth - 130 Ksi Specimen Finish - 63 Microinches 1.5 Axial Sinusoidal Loading ումումումուկումուր -60 2, 33 Environment - Air 180-160 -140 -120 -100 -80 Alternating Strees. 9.0-160 100 20 Maximum Stress Figure B11

Ultimate Tensile Strength - Smooth - 157 Ksi -- Notched (K+=3.0)-210 Ksi

CONSTANT LIFE DIAGRAM -17-7 PH RH 950 FORGING

Temperature - 800°F

## SECTION VC

## 17-7 PH TH 1050 FORGING

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TABLE CI

TENSILE TEST DATA FOR 17-7 PH, TH 1050 FORGING MATERIAL

	•=4							Ì
Notched $K_t \approx 3.0$	Ultimate Tensile Strength, ksi	203. 9 210. 8 234. 0 216. 2	109. 2 147. 1 233. 2 163. 2	223. 1 225. 8 218. 8 222. 6	161. 2 211. 8 216. 8 196. 6	200, 7 193, 1 192, 3 195, 4	196. 4 200. 8 200. 9 199. 4	
Notched	Spec. No.	G45III G46III G47III	S1III S2III S3	G48 G49 J35	S4 S5 S6	J36 J37 J38	UI U2 U3	
	Tensile Modulus 10 <sup>6</sup> psi	30. 2 29. 9 30. 5	30, 1 29, 4 29, 1 29, 5	ı	l			
	Reduction of Area,%	40, 4 39, 3 39, 3	1.0	42. 2 41. 6 39. 8 41. 2	3, 2 3, 9 6, 1 3, 3	45.8 45.8 46.4 46.0	23, 4 4, 7 3, 2 10, 4	
	Elongation in 1", %	14. 0 14. 0 14. 0	2.0	12.0 11.0 11.0 11.3	1. 0 1. 0 4. 0 2. 0	13.0 12.0 12.0 12.3	7. 0 2. 0 2. 0 4. 7	
FORGING MATERIAL Smooth	0.2% Offset , Yield Strength, ksi	183. 6 183. 6 181. 1 182. 8	166. 8 165. 3 128. 6 153. 6	155.1 155.1 158.1 156.1	_(1) 148.9 158.1 153.5	136. 3 135. 2 137. 7 136. 4	130, 6 -(1) 120, 4 125, 5	
FORGING	Ult. Tensile Strength, ksi	196.9 196.3 196.9 196.4	167. 9 173. 5 155. 1 165. 5	167.8 167.8 168.3 168.0	144.8 153.0 168.3 155.0	145, 9 144, 3 146, 4 145, 5	142.8 125.5 126.5 132.9	
	Spec. No.	E43 E42 E48	05 P2 U4	E44 E45 E46	P5 P6 P7	E47 E49 J34	P1 P3 P4	no yield
-	Specimen Orientation	J	E-	ı	H	L	T	Brittle fracture,
	Test Temp.	Room		4.009		800°F		(1) Britt

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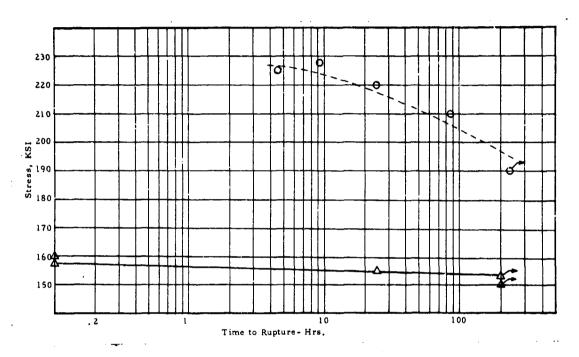
TABLE CII

#### STRESS RUPTURE DATA FOR 17-7 PH, TH 1050 FORGING MATERIAL 0. 252 SPECIMENS - LONGITUDINAL

Spec. No.	К <sub>t</sub>	Test Temp	Stress ksi	Life Hours
E36 E39 E38 E40 E37	1.0	600°F	160 158 155 153 150	0. 1 < 0. 05 25. 3 200. 0+ 207. 3+
E31 E32 E33 E34 E35	1.0	800°F	180 160 130 100 80, 0	< 0.05 < 0.05 0.6 79.4 187.0+
J41 J42 J39 J40 J43	3.0	600°F	225 228 220 210 190	4.6 9.3 24.0 87.3 240.0+
J44 J46 J47 J48 J49	3.0	800°F	200 180 170 160 148	0. 1 0. 7 4. 0 8. 9 24. 2

## 17-7 PH TH 1050 FORGING STRESS VS. TIME TO RUPTURE

Notched -----Smooth \_\_\_\_\_



## Figure Cl-600°F

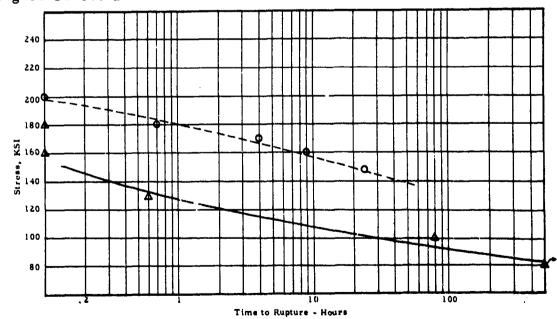


Figure C2-800°F

### TABLE CIII

#### FATIGUE TEST DATA

Material- 17-7 PH, TH 1050 Forging Type of Specimen-Longitudinal-Smooth Test Temperature-Room

Test Frequency - Cycles/Minute

A = .98 - 1050A = .50 - 1050

Specimen	"A"	Life,			
No.	Ratio	Sm	Sc	Kilocycles	
H-8-III H-13-III H-23-III H-42-III H-14-III J-31-III H-25-III H-12-III J-32-III	0 <b>.</b> 98	60.0 61.7 61.7 65.5 65.5 69.0 72.7 72.7 76.4 76.4	58.8 60.5 60.5 64.2 64.2 67.6 71.2 71.2 74.9	118.8 122.2 122.2 129.7 129.7 136.6 143.9 143.9 151.3	4, 228. 3, 275. 0 3, 175. 0 833. 0 6, 257. 0 1, 129. 0 174. 0 609. 0 198. 0 333. 0
J-27-III J-26-III J-19-III J-29-III J-11-III J-20-III J-10-III J-9-III J-8-III J-13-III	O. 5	43.6 87.4 102.0 105.5 108.9 108.9 116.3 123.9 130.5	21.8 43.7 51.0 52.8 54.4 54.4 54.4 58.2 62.0 65.2	65. 4 131. 1 153. 0 158. 3 163. 3 163. 3 163. 3 174. 5 185. 9 195. 7	10, 342. 0+ 9, 000. 0+ 1, 909. 0 795. 0 177. 0 324. 0 146. 0 197.0 136. 0 Failed Loading

### TABLE CIV

### FATIGUE TEST DATA

Material- 17-7 PH TH 1050 Forging
Type of Specimen- Longitudinal - Smooth
Test Temperature-600°F

Test Frequency-Cycles/Minute

A = -4300

A = .98 - 1800

Specimen	"A"	Appli	ksi	Life,	
No.	Ratio	Sm	Sa	Sc	Kilocycles
J-1 J-14 J-6 J-15 J-17 J-5 J-16 J-18 J-4 J-21	Infinity	0	80. 0 85. 0 90. 0 90. 0 95. 0 95. 0 100. 0 100. 0	80. 0 85. 0 90. 0 95. 0 95. 0 100. 0 105. 0	12,092.0+ 11,616.0+ 5,103.0 3,675.0 120.0 56.0 41.0 102.0 70.0 41.0
H-5 H-11 H-7 H-3 H-9 H-10 H-15	0, 98	50. 2 54. 6 55. 0 6 0. 0 6 0. 1 6 0. 4 64. 9 80. 0	49. 2 53. 5 53. 9 58. 8 58. 9 59. 2 63. 6 78. 4	99. 4 108. 1 108. 9 118. 8 119. 0 119. 6 128. 5 158. 4	10,088.0+ 10,028.0+ 13,032.0+ 6,504.0 12.0 1,908.0 79.0 Failed Loading
H-20 H-19 H-16 H-27 H-28 H-26 H-24 H-22	0.50	90.0 95.5 99.4 100.0 105.0 106.0 110.1	45, 0 47, 5 49, 7 50, 0 52, 5 53, 0 55, 0 55, 0	135.0 142.5 149.1 150.0 157.5 159.0 159.2 165.0	10,052.0+ 7,417.0 5,038.0 5,462.0 46.0 28.0 29.0 4,748.0 51.0

TABLE CV

### FATIGUE TEST DATA

Material- 17-7 PH TH 1050 Forging Type of Specimen- Longitudinal - Smooth Test Temperature- 800°F

Test Frequency - Cycles/Minute

A = 99 - 4300

A = .98 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
J-3 J-7 J-2	Infinity	0	75.0 80.0 80.0	75, 0 80, 0 80, 0	10,249.0+ 10,953.0+ 5,676.0
J-22 J-30 J-24 X-8 J-23			85.0 85.0 90.0 90.0 95.0	85, 0 85, 0 90, 0 90, 0 95, 0	7,890.0 7,365.0 37.0 27.0 38.0
X-15 J-25			95.0 100.0	95. 0 100. 0	15.0 17.0
H-43-III H-47-III H-40-III H-39-III H-45-III H-48-III H-32-III H-44-III H-49-III	0. 98	55. 0 55. 0 58. 0 58. 0 60. 0 60. 0 60. 0 65. 0	53. 9 53. 9 56. 8 56. 8 56. 8 58. 8 58. 8 63. 7 63. 7	108.9 108.9 114.8 114.8 114.8 118.8 118.8 118.8 128.7	10,051,0+ 13,653,0+ 8,303.0 2,934.0 2,328.0 506.0 109.0 51.0 26.0 26.0
J-12 H-36 H-33 H-35 H-30 H-37 J-28 H-34 H-38 H-31	0, 50	75. 0 75. 0 75. 0 80. 0 80. 0 90. 0 90. 0 95. 0 96. 7	37. 5 37. 5 37. 5 40. 0 40. 0 42. 5 45. 0 45. 0 47. 5 48. 3	112.5 112.5 112.5 120.0 120.0 127.5 135.0 135.0 142.5	10,000,0+ 9,517.0+ 3,009.0 10,281,0+ 6,219.0 7,851.0 1,999.0 278.0 42.0 8.0

### TABLE CVI

# FATIGUE TEST DATA

Material- 17-7 PH, TH 1050 Forging
Type of Specimen- Longitudinal - Notched
Test Temperature- Room

Test Frequency - Cycles/Minute

A = -4300A = .98 - 1050

Specimen	''A''	Appli	ed Stress,	Life,	
No.	Ratio	Sm	Sa	Sc	Kilocycles
F-14	Infinity	0	30.0	30.0	10,000.0+
F-19			32.0	32. 0	4, 491. 0
F-16			35, 0	35.0	4, 348, 0
F-15			35.0	35.0	189. 0
F-13			40.0	40.0	580.0
F-17			50.0	50.0	125.0
F-20			55.0	55.0	102.0
F-18			60.0	60.0	10.0
F-12		•	70.0	70.0	9.0
F-11			100.0	100.0	6, 0
F-27-III	0, 98	28, 0	27, 5	55, 5	10,141,0+
F-28-III		30, 4	29.8	60. 2	3, 457. 0
F-29-III		32.6	31.9	64. 5	2, 266, 0
F-22-III		35, 1	34, 4	69. 5	214,0
F-30-III		37. 3	36. 5	73.8	141.0
F-24-III		46.7	45.6	92. 3	54.0
F-21-III		46. 7	45, 6	92.3	37.0
F-23-III		51.4	50, 3	101.7	29. 0
F-25-III		56. 1	55, 0	111,1	9. 4
F-26-III		65. 4	64. 0	129.4	4, 1
F-5-III	0, 5	32, 6	16, 3	48. 9	11,415,0+
F-8-III		37. 3	18, 6	55. 9	10,699.04
F-4-III		42, 1	21.0	63.1	1,747.0
F-6-III		46. 7	23, 4	70, 1	387, 0
F-3-III		56. 1	28, 0	84.1	108,0
F-2-III		65, 4	32, 7	98. 1	74.0
F-1-III		70, 0	35, 0	105.0	66.0
F-9-III		84, 0	<b>4</b> 2, 0	126. 0	59.0
F-10-III		84, 0	42, 0	126.0	24.0
F-7-111		93, 5	46.8	140, 3	16. 0
					,

### TABLE CVII

# FATIGUE TEST DATA

Material- 17-7 PH TH 1050 Forging
Type of Specimen- Longitudinal, Notched
Test Temperature- 600°F

Test Frequency - Cycles/Minute

A = -4300

A = .98 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
G-4 G-3	Infinity	0	30.0 35.0	30, 0 35, 0	12,098,0+ 1,917.0
G-8	1	l l	35.0	35.0	337. 0
G-5	1 1		40.0	40.0	141.0
G-2			40.0	40.0	78, 0
F-49	i		45.0	45.0	98. 0
G-6			45.0	45.0	71.0
F-48	1 1		50.0	50.0	52, 0
G-7			60.0	60.0	22, 0
F-47	<u> </u>		70.0	70.0	12, 0
F-35	0, 98	20. 2	19.8	40.0	10,037.0+
F-36		30.6	29. 4	60, 0	10, 112, 0+
F-38		32, 8	32, 2	65. 0	10,000.0+
F-41		33, 3	32. 7	66, 0	109.0
F-40		33, 8	33, 2	67. 0	75, 0
F-39		34, 3	33, 7	68. 0	66, 0
F-37		35, 4	34.6	70.0	37. 0
F-34	1	40, 4	39.6	80.0	27.0
F-33		50, 5	49.5	100.0	8.0
F-32		60, 6	59. 4	120.0	6, 0
G-10	0, 5	50, 0	25, 0	75. 0	10,000.0+
G-43		50, 0	25. 0	75. 0	5, 286. 0
G-11		51,7	25, 8	77.5	10, 258. 04
B-36		53, 4	26.6	80.0	12,721.04
G-12		53, 3	26. 7	80.0	9,512.0
G-41		53, 3	26. 7	80.0	75. 0
G-13		56. 7	28.3	85, 0	12,179.04
B-35		56.7	28.3	85.0	57. 0 37. 0
G-42		60. 0 60. 0	30. 0 30. 0	90. 0 90. 0	29. 0
B-34 B-43	1	63, 4	31.6	95. 0	30. 0
B-33		66.6	33, 3	100.0	24. 0
X-22		93, 3	46. 7	140.0	13.0
X-16		120, 0	60.0	180. 0	4.0

# TABLE C VIII

#### FATIGUE TEST DATA

Material - 17-7 PH, TH 1050 Forging Type of Specimen - Longitudinal - Notched Test Temperature - 800°F

Test Frequency - Cycles/Minute

A = -4300

A = .98 - 1800

A = .50 - 1800\*

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
G-14	Infinity	0	30. 0	30, 0	11, 286. 0+
G-17			32.5	32, 5	11,953.0+
G-16			35.0	35. 0	5,044.0
G-19			35, 0	35.0	555. 0
G-18			37.5	37.5	162.0
G-20	Į l		37.5	37.5	148.0
G-15			40.0	40.0	115.0
G-21			45.0	45.0	48.0
G-22			50.0	50.0	22. 0
G-23			60.0	60.0	12.0
F-45	0. 98	25. 3	24, 7	50, 0	10, 402, 0+
G-35		27.8	27, 2	55, 0	10,031.0+
G-37	Ì	29. 0	28.5	57, 5	15, 103, 0+
G-38		29.8	29. 2	59.0	85, 0
F-44		30. 3	29.7	60.0	51, 0
G-40		35, 4	34, 6	70, 0	29, 0
F-43	Į i	35, 4	34, 6	70, 0	19.0
G-39	į į	37.9	37, 1	75, 0	22. 0
F-46		40, 4	39.6	80.0	20, 0
G-44		40.4	39, 6	80, 0	15.0
G-24	0, 5	43, 3	21,7	65, 0	10, 919, 0+
G-33	1	43, 3	21,7	65, 0	10, 498, 0+
G-32		45, 0	22, 5	67.5	11,701.0+
B-42		46, 6	23, 3	70, 0	12, 402, 0+*
G-34		46, 6	23, 3	70, 0	12, 166, 0+
G-31		46.6	23, 3	70.0	92. 0
G-27	1	50.0	25, 0	75.0	5, 378. 0
G-30		50.0	25, 0	75.0	88.0
B-41		50, 0	25.0	75. 0	48.0 *
G-28		51.6	25, 8	77.5	73.0
G-29		51.6	25, 8	77.5	67.0
B-37		53, 4	26.6	80. 0	635, 0
G-25	1	53, 3	26.7	80.0	66.0
B-40	1	53, 4	26, 6	80.0	40.0 *
B-39	1	56.7	28.3	85, 0	51.0 *
B-38		60, 0	30, 0	90, 0	30.0 *
	1	1	1	<u></u>	1

LABORATORIES	Chart No.: Date:	Test Frequency-	Cycles/Minute A=.50 - 1050 A=.98 - 1050								
17-7 PH TH 1050 Forging Environment - Air - 196 Ksi 33 Ksi imen Finish 63 Microinches											E
- 17-7 F Envi h - 196 I 183 Ksi	A=. 98		j								CYCLES TO FAILURE
Temperature - Room Ultimate Tensile Strengt Tensile Yield Strength - Longitudinal, Smooth Spe											2 3 4 5 6 7 8 5
		200,000	160,000 F	140000 F. SS3	120,000 I X T S I	00 WIX	000 OW	000,09	40,000	20,000	2 3 4 5 6 78 9

ST ST ST ST ST ST ST ST ST ST ST ST ST S	No.:	Test Frequency =	Cycles/Minute A = . 50- 1800	A = .98 -1800 A =4300									V-1+	
3	Chart No.: Date:				1		1		11					98
oinches			4	4	4									10,000,000
H 1050 Forging ronment - Air Ssi Finish 63 Microinches	<u> </u>					C							E .	
17-7 PH TH 1050 Forging Environment - Air agth - 168 Ksi 1 - 156 Ksi Specimen Finish 63 Micr	ding A = . 50 4 A = . 98 1													1,000,000
S-N Curve - 17-7 PH TH 1 Temperature - 600°F Environ Ultimate Tensile Strength - 168 Ksi Tensile Yield Strength - 156 Ksi Longitudinal, Smooth Specimen Fir	oading A = . 50 A = . 98 A = .						+	+-					CYCLES TO	
S-N Curve - Temperature - 600°F Ultimate Tensile Stre Tensile Yield Strength Longitudinal, Smooth	Axial Sinusoidal Loading A = A = A = A =												C C	100,000
Temper Ultimate Tensile Longitud	Axial Si		4	27										
						G	/						0	10,000
													***************************************	
	900	180,000	7 .000		E22 900 900	120,000, AT		00 00 00 00 00 00 00 00 00 00 00 00 00	00 00 AM	000.09	40,000	000 07 igure		1,000

SPS	Chart No.:	Test	Frequency - Cycle/Minute	A = .98 - 1800 A = .96 - 4300				4.6						T		191
S-N Curve - 17-7 PH TH 1050 Forging  Temperature - 800°F Environment - Air Ultimate Tensile Strength - 146 Ksi  Tensile Yield Strength - 136 Ksi  Longitudinal, Smooth Specimen Finish 63 Microinches	A = . 50									8					CYCLES TO FAILIIBE	4
						<u>/</u>			*/ /							3 4 5 6 78 9
		200,000	180,000	2 d	140,000		120,000 TS	MU	100 00 00 1 MI	S S S S S S S S S S S S S S S S S S S	_	90,000	40,000	000'02 Figu		75

'V () 17 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Temperature - Room  Unitimate Tensile Strength - 216 Ksi  Longitudinal, Notched Specimen Finish-63 Microinches  Kt=3.0  Axial Sinusoidal Loading  A = .50  A = .98  A = .98  A = .00  A = .00  A = .00  A = .00  A = .00  A = .00  A = .00  A = .00
--	---

Cycles/Minute A = .98 - 18004300 Frequency -**△**= 5= 1800 LABORATORIES 5= δ= Test Chart No .: \_\_ Date: 000,000,0 Ultimate Tensile Strength - 195 Ksi Longitudinal, Notched Specimen Finish-63 Microinches Environment - Air ۵ S-N Curve 17-7 PH TH 1050 Forging FAILURE A = .50----TO K<sub>t</sub>=3.0 Axial Sinusoidal Loading CYCLES Temperature - 800°F MAXIMUM STRESS, P.S.I. 140,000 120,000 300,000 200,000 180,000 160,000 60,000 90,000 40,000 20,000 Figure C8.

Ultimate Tensile Strength - Smooth- 196 KSI-- Notched (Kt=3.0)-216 KSI 0, 25 0, 6 Smooth Notched 0.43 CONSTANT LIFE DIAGRAM- 17-7 PH TH 1050 FORGING .67 Tensile Yield Strength- Smooth- 183 KSI Specimen Finish - 63 Microinches Axial Sinusoidal Loading Temperature - Room ուկուդուկուդուրույուկու 2, 33 Environment - Air 4.0 9.0 © 4 Figure C9 240 280 320 360 R= -1 Assimum Stress,

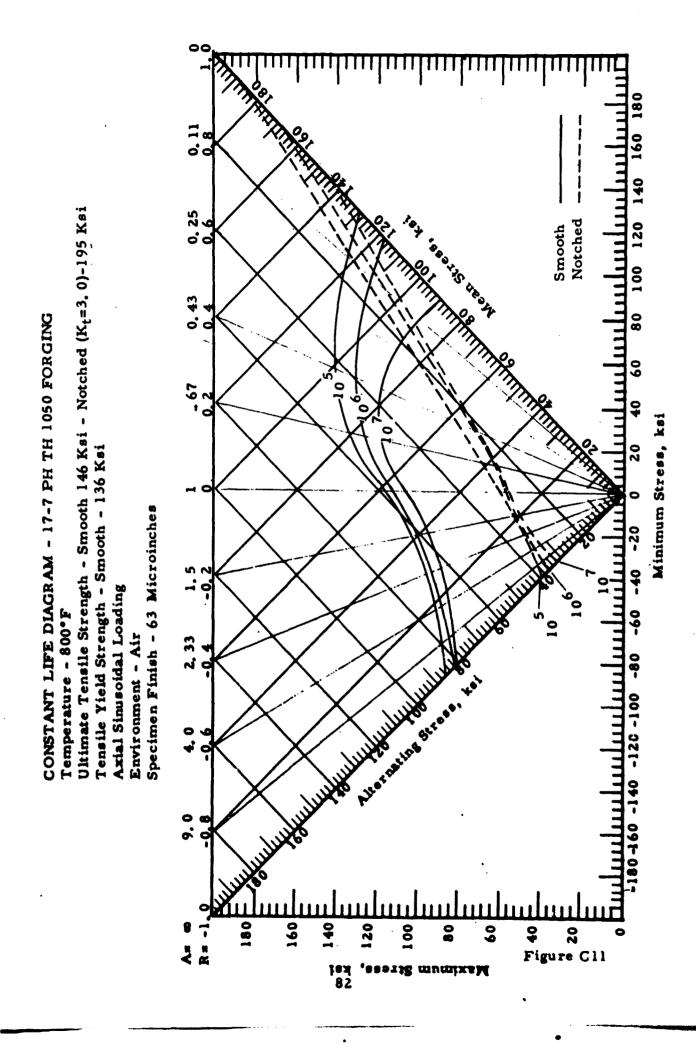
30

Minimum Stress, ksi

Ultimate Tensile Strength - Smooth - 168 KSI -- Notched (Kt=3.0)-223 KSI 0.25 Notched Smooth 0.43 CONSTANT LIFE DIAGRAM 17-7 PH TH 1050 FORGING . 67 Tensile Yield Strength - Smooth - 156 KSI Specimen Finish - 63 Microinches 1.5 Axial Sinusoidal Loading Temperature - 600°F Environmental - Air 2, 33 9.0 280 240 360 320 Figure C10

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Minimum Stress, ksi



# SECTION VD

# PH 15-7 Mo RH 950 SHEET

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TABLE DI

TENSILE TEST DATA FOR PH 15-7 Mo, RH 950 SHEET MATERIAL

	ile						
= 3, 0	Ultimate Tensile Strength, ksi	263, 4 263, 8 <u>264, 9</u> 264, 0	272, 0 274, 7 273, 8 273, 5	226. 3 226. 4 223. 3 225. 3	225. 4 224. 2 224. 0 224. 5	138, 4 137, 2 138, 1 137, 9	102, 1 131, 1 121, 8 118, 3
Notched K	Specimen	QA-1 QA-2 QA-3	TA-30 TA-31 TA-32	QA-9 QA-8 QA-7	RA-40 RA-42 RA-39	QA-6 QA-5 QA-4	TA-33 TA-34 TA-35
MAIERIAL	Elongation in 2 inches %			5, 5 5, 0 5, 3	5.0 5.0 5.0	14.5 12.0 13.0 13.2	7.5 11.0 10.5 9.7
Smooth	0, 2% Offset Yield Strength, ksi			176.8 175.8 188.1 180.2	177. 2 185. 3 181. 2 181. 2	89. 0 94. 5 83. 0 88. 8	100. 4 95. 7 101. 2 99. 1
	Ult, Tensile Strength, ksi			206. 2 204. 7 204. 7 204. 7 205. 2	209. 1 209. 8 210. 1 209. 3	106.8 112.7 109.4 109.6	106. 0 113. 2 120. 6 113. 3
	Spec. No.	1		P-14 P-15 P-16	U-1 U-2 U-3	P-5 P-12 P-13	0-4 0-5 0-6
•	Specimen Orientation	ı	<b>H</b>	บ	H	1	T
	Test Temp.	Room		600°F		1000°F	

TABLE DII

STRESS RUPTURE DATA FOR PH 15-7 MO,
RH 950 SHEET MATERIAL 0. 050 THICK - TRANSVERSE

Spec. No.	K <sub>t</sub>	Test Temp.	Stress ksi	Life Hours
	**t	remp.	K91	11001.5
บ-8	1.0	600°F	205.0	<b>&lt;</b> 0.05
S-11			200	14,6
S-26			197.5	46.2
U-9			195.0	190.2
บ-7			185.0	572, 2+
S-31	1.0	1000°F	100	0, 1
S-30	Ť		75	7.5
S-29		}	65	24.7
S-27			60 .	98. 2
S-28			55	183. 2+
TA29	3, 0	600°F	220.0	0, 1
TA27			216.0	6.1
TA26	}		214.0	35.8
TA25			212	7.0
TA28			210	279.5+
U-48	3.0	1000°F	70	19.5
TA37			68	26.1
TA36	}		65	100.0
U-47	i		60	138.8
U-49			58	285, 5+

### PH 15-7 MoRH 950 SHEET STRESS VS. TIME TO RUPTURE

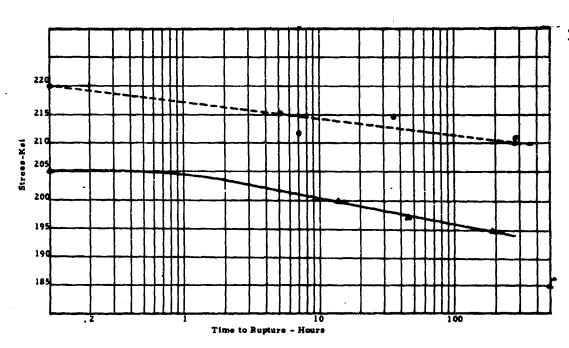


Figure D1-600°F

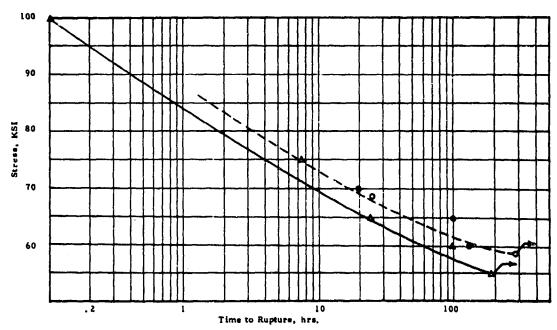


Figure D2-1000°F

### TABLE DIII

### FATIGUE TEST DATA

Material- PH 15-7 Mo, RH 950 Sheet Material Type of Specimen- Transverse- Smooth Test Temperature-600°F

Test Frequency - Cycles/Minute

A = .98 - 1200A = .50 - 1200

Specimen	"A"	Appli	ed Stress	, ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
S34	0.98	50, 5	49.5	100, 0	10,000,0+
S45		50, 5	49.5	100, 0	10,000,0+
S36 S37		55, 5	54.5	110.0	7,231.0
S38		60.6 63.1	59.4 61.9	120, 0 125, 0	2,776.0 1,763.0
S40		65.7	64. 3	130, 0	902. 0
S46		70.7	69. 3	140, 0	660. 0
S39		70.7	69.3	140.0	350. 0
S24		75.7	74.3	150.0	20. 0
S32	0.5	48. 0	24. 0	72. 0	10,000.0+
S20		52. 0	26. 0	78. 0	10,000.0+
S18		64. 0	32. 0	96. 0	8,900.0+
S16		72, 0	36. 0	108, 0	10,000,0+
TA14		80, 0	40. 0	120, 0	10,584.0+
TA12		85, 0	42. 5	127, 5	7,916.4
TA11		90, 0	45. 0	135, 0	9,086.0
S14	·	100.0	50. 0	150. 0	57. 0
S15		103.3	51. 7	155. 0	24. 0
S17		106.5	53. 5	160. 0	22. 0

#### TABLE DIV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH950 Sheet Material Type of Specimen- Transverse-Smooth Test Temperature-1000°F Test Frequency - Cycles/Minute A=. 98-3600 A=. 50-1200

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Specimen	"A"	Appli	ed Stress	, ksi	Life,
No.	Ratio	Sn:	Sa	Sc	Kilocycles
TA-48 TA-47 TA-46 RA-47 RA-46 TA-42 TA-43 TA-44 TA-45 TA-49	0.98	36. 1 37. 9 38. 5 40. 4 42. 9 45. 5 48. 0 5 0. 5 53. 0 58. 3	35.3 37.1 37.7 39.6 42.1 44.6 47.0 49.5 52.0 57.2	72.8 75.0 77.5 80.0 85.0 90.0 95.0 100.0	10,000.0+ 6,566.0 3,220.0 8,503.0 4,690.0 2,657.0 964.0 50.0 29.0 2,111.0
TA 10 TA 20 TA 3 TA 2 TA 6 TA 1 S 12 S 13	0.50	53. 4 56. 7 60. 0 63. 4 66. 7 73. 4 80. 0 86. 7	26.6 28.3 30.0 31.6 33.3 36.6 40.0 43.3	80. 0 85. 0 90. 0 95. 0 100. 0 110. 0 120. 0 130. 0	10,000.0+ 9,238.0 3,218.0 1,931.0 647.0 383.0 178.0 63.0

#### TABLE DV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH 950 Sheet Material Type of Specimen- Transverse Notched Test Temperature- Room Test Frequency-Cycles/minute
A=.98-1200
A=.50-1200

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
RA-32 RA-21 RA-27 RA-23 RA-3 RA-24 RA-22 RA-32 RA-32	0. 98	21. 9 24. 1 25. 9 26. 0 26. 2 27. 8 28. 2 32. 0 39. 6	21.5 23.9 25.4 25.7 27.2 27.3 31.4 38.8	43. 4 48. 0 51. 3 51. 4 51. 9 55. 0 55. 5 63. 4 78. 4	10, 130. 0+ 11, 600. 0 2, 259. 0 2, 437. 0 191. 0 247. 0 218. 0 64. 0 26. 0
RA-28  U-14  RA-9  RA-20  RA-13  RA-11  RA-5  RA-8  RA-7  RA-6	0, 50	48. 3 40. 3 43. 4 43. 8 44. 2 46. 0 46. 7 50. 0 53. 4 60. 0	20. 1 21. 7 21. 9 22. 1 23. 0 23. 3 25. 0 26. 6 30. 0	95, 5 60, 4 65, 0 65, 7 66, 3 69, 0 70, 0 75, 0 80, 0 90, 0	10.0 4,042.0 1,477.0 10,147.4+ 10,000.0+ 1,759.6 68.0 52.0 34.0 14.0

### TABLE DVI

#### FATIGUE TEST DATA

Material- PH 15-7 Mo, RH 950 Sheet Material Test Frequency-Cycles/Minute Type of Specimen- Transverse, Notched A = .98 -1200

Test Temperature-600°F

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
U-16 RA-45 RA-44 RA-43 U-17 U-15 U-18 U-19	0.98	25. 3 27. 8 30. 3 32. 8 35. 4 35. 4 50. 5 63. 1	24.8 27.2 29.7 32.2 34.7 34.7 49.5 61.9	5 0. 0 5 5. 0 60. 0 65. 0 70. 0 70. 0 100. 0 125. 0	12,750,0+ 10,294,0+ 8,900,0+ 47.0 20.0 15.0 4.0 2.0
RA-36 TA-22 TA-21 RA-38 RA-37 TA-24 TA-23 RA-35 RA-35 RA-35	0, 50	33, 3 40, 0 43, 4 46, 7 53, 4 56, 7 60, 0 66, 7 100, 0 133, 3	16.7 20.0 21.6 23.3 26.6 28.3 30.0 33.3 50.0	50. 0 60. 0 65. 0 70. 0 80. 0 85. 0 90. 0 100. 0 150. 0 200. 0	10,885.0+ 10,317.0+ 3,208.0 9,297.0 1,072.0 11.0 11.0 5.0 2.0 1.0

### TABLE DVII

#### FATIGUE TEST DATA

Material - PH 15-7 Mo RH 950 Sheet Material Type of Specimen-Transverse, Notched Test Temperature-1000°F Test Frequency- Cycles/Minute A= .98-1200 A= .50-1200

Specimen	"A"	Appli	ed Stress	, ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
U-46	0.98	15, 2	14.9	30.0	10,034.0+
U-44		16.4	15.3	32.5	2,798.0
U-45	1	16.4	15.3	32.5	518.0
U-43	1	17.7	17.3	35.0	8, 230. 0
RA-29	1 1	20.2	19.8	40.0	1,643.0
U-42		20.2	19.8	40.0	548.0
RA-26	1 1	22.7	22, 3	45.0	924.0
TA-38	1 1	22.7	22.3	45.0	90.0
RA-14		25.3	24.8	50.0	8.0
TA-40		40.4	39,6	80.0	3.0
U-27	0.50	26.7	13, 3	40, 0	10,000.0+
U-25		30, 0	15.0	45.0	6, 410.0
U-23		33.3	16.7	50.0	4, 422. 0
U-23		36, 7	18, 3	55.0	668.0
U-30	1	40.0	20.0	60.0	794.0
U-26		43, 4	21.6	65.0	58.0
U-31		46.7	23.3	70.0	123.0
U-22		53, 4	26.6	80.0	28.0
U-24		60.0	30, 0	90.0	8.0

1.2. 4. 28. 88. 88. 88. 88. 88. 88. 88. 88. 88	20.000
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		986.94			8	LS	32 88 91			Is			=V	A= .50	Axial Sinusoidal Loading Gbart No.:	Tensile Yield Strength - 99.1 KSI Transverse, Smooth Specimen Finish - 63 Microinches	naile Strength-113, 3 KSI	for PH 15-7 Mo RH 950 Sheet	Dearons No.: Test Frequency Cycles/Mi A=. 50-12( A=. 98-12(	A= .50  A= .50  A= .98  A= .50  A= .98  A= .98  A= .98  A= .98  A= .98  A= .98  A= .98  A= .98  A= .98  A= .98	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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A = .50 - 1200 A = .98 - 1200Frequency -Cycles/Minute LABORATORIES Test Chart No.: Date Transverse, Notched Specimen Finish-63 Microinches Environment - Air PH 15-7 Mo RH 950 Sheet 4 A = . 50 ---- A ---- A = . 98 -----FAILURE Ultimate Tensile Strength - 225 Ksi TO. Kr=3.0 Axial Sinusoidal Loading CYCLES Temperature - 600°F S-N Curve MAXIMUM STRESS, .S.9 r 120,000 140,000 20,000 200,000 180,000 80,000 49,000 28,000 160,000 40,000 96

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SPS	Chart No.:	Test	Cycles/minute	A=. 5-1200 A=. 98-1200	I											9-11	
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ve - tture Ten	Simusoidal Loading A = . 50 = . A = . 98															H CYCLES TO	100 000
S-N Curv Tempera Ultimate Transver	Axial Sir									•	4						2 4 5 4 7
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			180,000	Sq. 990	38. 2000 201	25.08.02.	•	25 25 20 20 20 20 20 20 20 20 20 20 20 20 20	VW	80.000	60 000		8 80	ure	20,660		7

0, 11 0, 8 0, 25 Notched 0.43 CONSTANT LIFE DIAGRAM - PH 15-7 Mo RH 950 SHEET Ultimate Tensile Strength - Notched (Kt=3.0)-273.5 KSI . 67 Minimum Stress, ksi Specimen Finish - 63 Microinches 1.5 Axial Sinusoidal Loading Temperature - Room 1360-320-280 -240 -200 -160 -14 Environment - Air 2, 33 4.0 9.0 320 R= -1 Figure D8 , asori& mumixaM 98

0, 25 Smooth Notched 0, 43 67 Minimum Stress, ksi Specimen Finish - 63 Microinches 1.5 Environment - Air 2, 33 9.0 280 320 360 A= 8 R= -1 Figure D 9 Maximum Stress,

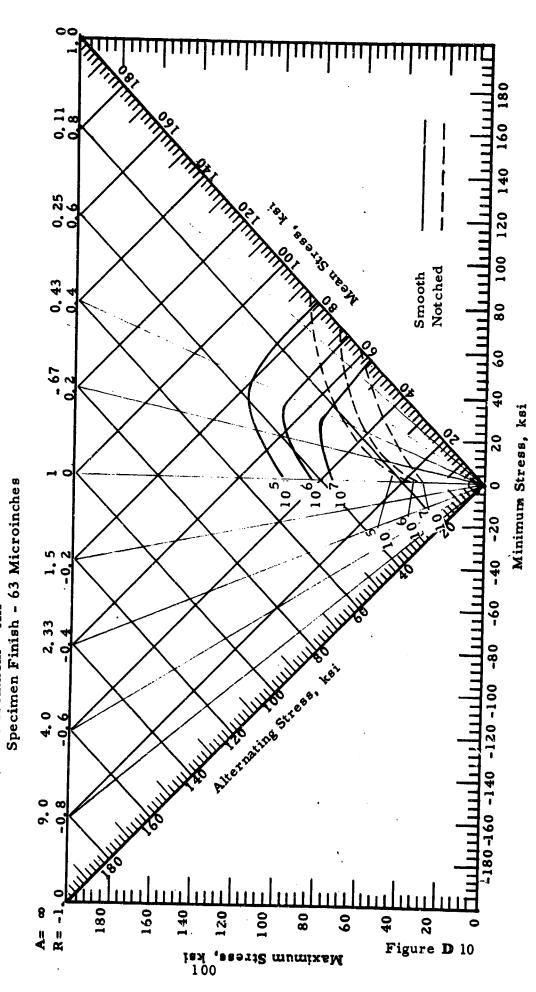
Ultimate Tensile Strength-Smooth-209 KSI-Notched (Kt=3, 0)-224 KSI Tensile Yield Strength- Smooth - 181 KSI

Axial Sinusoidal Loading

CONSTANT LIFE DIAGRAM - PH 15-7 Mo RH 950 SHEET

Temperature - 600°F

Ultimate Tensile Strength-Smooth-113, 3 KSI- Notched (Kt=3, 0)-118 KSI CONSTANT LIFE DIAGRAM - PH 15-7 Mo RH 950 SHEET Tensile Yield Strength - Smooth - 99, 1 KSI Axial Sinusoidal Loading Temperature - 1000°F Environment - Air



# SECTION VE

# PH 15-7 Mo-RH 950 FORGING

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TABLE E I

TENSILE TEST DATA FOR PH 15-7 Mo, RH 950 FORGING MATERIAL

t = 3.0	Ult, Tensile Strength, ksi	178.9 185.8 166.2 177.0	126.6 110.9 129.7 122.4	253. 7 274. 3 271. 1 266. 4	236. 2 254. 2 268. 3 252. 9	178.1 176.5 183.0 179.2	177.1 179.6 179.6 178.8
Notched Kt = 3.0	Specimen	H-44 H-45 H-46	S-2 S-3	H-42 H-43 H-47	S-8 8-5 6-5	J-11 J-12 J-13	S-7 T-1 T-2
	Tensile Modulus, 10 <sup>6</sup> psi	29. 6 29. 7 <u>29. 7</u> 29. 7	29.7 29.9 29.2 29.6				
	Reduction of Area,%	30. 6 25. 2 10. 8 22. 2	1 1 1	44, 0 45, 2 45, 2 44, 8	14.6 7.9 4.7 9.1	65.9 68.2 69.5 67.9	49. 3 48. 7 56. 9 51. 6
	Elongation in 1",%	11. 0 10. 0 6. 0	1.0 1.0 1.0	12. 0 13. 0 13. 0 12. 7	6. 0 5. 0 3. 0 4. 7	17.0 17.0 20.0 18.0	15.0 16.0 16.0 15.7
SMOOTH	0.2% Offset Yield Strength, ksi	198.9 197.9 202.0 199.6	, , ,	168. 3 158. 1 161. 2 162. 5	160, 2 160, 2 151, 0 157, 1	96. 9 102. 0 103. 0 100. 6	100. 0 96. 9 91. 8 96. 2
	Ult. Tensile Strength,ksi	234. 6 232. 6 234. 6 233. 9	123, 4 151, 1 140, 8 138, 4	198. 9 197. 9 198. 4 198. 4	199, 4 195, 9 187, 7 194, 3	131. 6 122. 4 124. 4 126. 1	130, 6 129, 5 126, 5 128, 8
	Spec. No.	F35 F32 F34	0-1 0-2 0-4	F38 F37 F36	U-1 U-2 U-4	F48 F49 F39	0-5 0-6 0-7
	Specimen Orientation	ı	H	ы	£-i	J	H
	Test, Temp.	Room		103 F	PRECEDING PA	60 00 01 GE BLANK	

TABLE EII

STRESS RUPTURE DATA FOR PH 15-7 Mo,
RH950 FORGING MATERIAL-LONGITUDINAL

Spec. No.	К <sub>t</sub>	Test Temp.	Stress ksi	Life Hrs.
F26 F27 F28 F29 F25	1, 0	600°F	150 180 190 200 210	254, 8+ 189, 0+ 283, 6+ <0, 05 <0, 05
F41 F46 F44 F43 F40	1.0	1000°F	50 60 70 75 100	257. 7+ 192. 4+ 68. 3 53. 5 <0. 05
J1 J2 J3 J4 J5	3, 0	600°F	160 230 260 270 280	642.3+ 189.3+ 255.9+ <0.05 <0.05
J10 H49 H48 J7 J6	3, 0	1000°F	65 90 110 140 160	189. 0+ 130. 1 17. 6 0. 1 <0. 05

### PH 15-7 Mo RH 950 FORGING STRESS VS. TIME TO RUPTURE

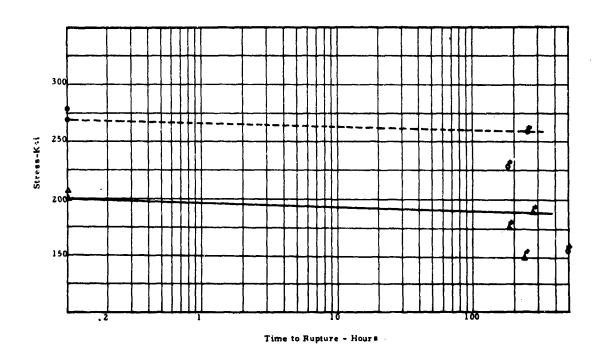


Figure El-600°F

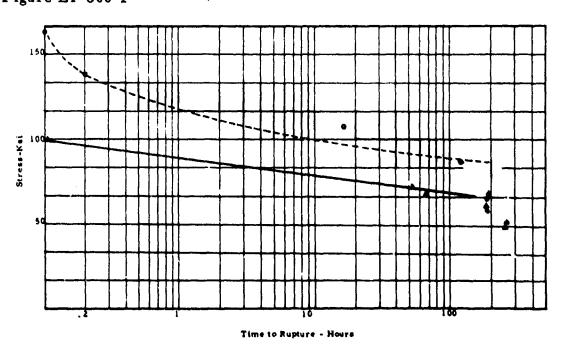


Figure E2-1000°F

#### TABLE EIII

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH950 Forging
Type of Specimen- Longitudinal Smooth
Test Temperature- Room

Test Frequency-Cycles/Minute

A= ca - 4300

Specimen No.	"A"	Appl	Life,		
	Ratio	Sm Sa Sc			Kilocycles
E-2	Infinity	. 0	80.0	80.0	12, 038, 0+
E-11	1		85.0	85.0	8, 343, 0
E7	1		85.0	85.0	3, 967. 0
E-6	1 1		90.0	90.0	7, 049. 0
E-10			90.0	90.0	1, 354, 0
E-5	1 1		100.0	100.0	429.0
E-4	1 1		110,0	110.0	185, 0
E-8	1 1		110,0	110.0	161.0
E-3	İ		120,0	120.0	51.0
E-9	1 1		180,0	180.0	14.0

#### TABLE EIV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH 950 Forging Type of Specimen- Longitudinal Smooth Test Temperature- 600°F

Test Frequency-Cycles/Minute

A = 69 - 4300

A = .98-1800

A = .50-1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
E-20	Infinity	0	85, 0	85.0	11, 146, 0+
E-19			90.0	900	7,803,0
	1 1		100.0	1000	6, 133, 0
E-24			110.0	110.0	399. 0
E-25			110.0	110.0	36.0
E-22			120.0	120.0	39.0
E-26			120.0	120.0	35.0
E-21			130,0	130.0	15, 0
E-23	]		130.0	130.0	15.0
			150.0	150.0	7.0
E-41	. 98	63, 1	61.9	125, 0	12, 414, 0+
J-32		65.7	64. 4	130.0	10,006.0+
E-40		68. 2	66.8	135.0	3, 201. 0
J-31		68, 2	66.8	135, 0	3, 090, 0
J-28	1	68, 2	66.8	135.0	2, 180. 0
E-37	1	70.7	69. 3	140.0	566. 0
E-38	i	73. 2	71.8	145.0	1, 467. 0
E-35		80.8	79. 2	160, 0	5, 0
J-26	. 50	98, 4	49, 2	147.5	19,000,0
J-25		100.0	50.0	150.0	6, 480, 0
J-24	į.	103, 4	51,6	155.0	4, 528. 0
J-21	1	106.7	53, 3	160.0	3,858.0
E-30	ı	110.1	55, 0	165.0	2,855.0
J-19	1	110, 1	55. 0	165.0	20, 0
J-17		113, 4	56.6	170.0	75.0
J-18	Į	113, 4	56.6	170.0	16.0
E-32		120.0	60.0	180.0	12.0

## TABLE EV

## FATIGUE TEST DATA

Material- PH 15-7 Mo RH 950 Forging Type of Specimen-Longitudinal Smooth Test Temperature- 1000°F

14

Test Frequency-Cycles/minute
A= ∞ -4300

A= .98 - 1800 A= .50 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
E43	Infinity	0	50.0	50. 0	10,628,0+
E46			60.0	60.0	18,066.0+
F2			65.0	65.0	10,000.0+
E45			70.0	70.0	4, 987. 0+
E44			80.0	80.0	1,095.0
F3	1		85.0	85.0	828.0
E42			90.0	90.0	80.0
E49			100.0	100.0	31.0
F4			110.0	110.0	9, 0
E47			110.0	110.0	4, 0
F12		45, 5	44, 6	90.0	10,075,0+
F11	0.98	48.0	47. 0	95.0	3, 735, 0
F5		50, 5	49.5	100.0	6,561,0
F6		55, 6	54, 5	110.0	1,328.0
F14		55.6	54, 5	110.0	1,272.0
F7		60.6	59. 4	120.0	757.0
F13		60, 6	59. 4	120,0	440, 0
F8		65, 7	64, 4	130.0	87, 0
F10		70, 7	69. 3	140, 0	Failed Loading
F24	0, 50	66. 7	33, 3	100, 0	10,066.0+
F23		70.0	35, 0	105.0	6, 204, 0
F22		73, 4	36.6	110.0	4, 073, 0
F21	[	76.7	38, 3	115.0	605. 0
F20	1	80.0	40, 0	120.0	485, 0
F17		83.4	41.6	125. 0	216.0
F15	Į.	86.7	43, 3	130.0	210.0
F16		93, 4	46. 6	140, 0	Failed Loading

#### TABLE E VI

#### FATIGUE TEST DATA

Material- PH 15-7 Mo, RH 950 Forging Type of Specimen-Longitudinal - Notched Test Temperature-Room

Test Frequency-Cycles/Minute

A = -4300

A = .98 - 1050

A = .50 - 1050

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
G22	Infinity	0	30.0	30, 0	11,579.0+
G23	1		35.0	35.0	10, 244, 0+
G30			37.0	37.0	10, 138, 0+
G24	1		40.0	40.0	4,138.0
G28			40.0	40.0	1,164,0
G21	<b>i</b>		40.0	40.0	184.0
G27			45.0	45.0	416.0
G20			50.0	50.0	133.0
G26			50.0	50.0	118.0
J15			60.0	60,0	45, 0
614	0.00	22.4			
G16	0, 98	23.6	23.0	46, 6	10,010,0+
G17		25.9	25, 4	51,3	10, 025, 0+
G18		28.4	27,8	56, 3	10, 833, 0+
G15		28, 4	27.8	56. 3	626. 0
G14		33.0	32, 3	65.3	339. 0
G19		37.8	37.0	74.8	703, 0
G13 G12		37,5	36.8	74.3	88.0
G12		42, 3	41.5	83.8	105, 0
J14		47, 0	46.1	93.0	38.0
J17		50, 5	49.5	100.0	12.0
G4		37, 5	18,8	56, 5	10,035.0+
G5	0.50	42, 3	21.2	63, 5	i 0, 006, 0+
<b>G</b> 10		47, 2	23, 6	70,8	10,090.0+
G3		<b>4</b> 7, 0	23, 5	70.6	10,052.0+
G6		<b>47</b> , 0	23, 5	70, 5	150.0
C8		52, 0	26. 0	78.0	677. 0
G2		52, 1	26. 0	78. 1	330, 0
G1		56, 5	28, 2	84.7	8,000.0
G9		56.7	28. 3	85.0	106.0
G7		66. 7	33, 3	100.0	108.0
	<u></u>				

#### TABLE EVII

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH 950 Forging Type of Specimen-Longitudinal Notched Test Temperature- 600°F

Test Frequency -Cycles/Minute

A = -4300

A = .98 - 1800

A = .5 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
G40	Infinity	0	32.5	32, 5	10,000.0+
G38		•	35.0	35.0	10,000 0+
G37			35.0	35.0	2,963.0
G31			40.0	40.0	5, 257. 0
G35			40.0	40,0	2,681.0
G34	1		50.0	50.0	852.0
G39			50.0	50 <b>.</b> 0	61.0
G36	1		55.0	55, 0	23.0
G32	1		60.0	60.0	19.0
G33			70.0	70.0	10.0
H-3	. 98	35.4	34.7	70. 0	10,000,0+
H-10		36.2	35.9	72,5	12,000.0+
H-4	1	37.9	37.1	<b>75.</b> 0	253.0
H-5		40.4	39.6	80,0	36.0
H-2		40.4	39.6	80,0	18.0
H-9		42.9	42.1	85, 0	24, 0
H-11		45.5	44.6	90.0	20,0
H-6		50.5	49.5	100,0	45.0
H-8		50.5	49.5	100,0	9.0
H-7		55.6	54.5	110.0	8.0
G43	. 50	53, 4	26.6	80,0	12,287.0+
G47		56.7	28.3	85, 0	3, 342, 0
G45		60, 0	30.0	9c. 0	4,686.0
G49		63, 4	31.6	95.0	32. 0
G46	<b>i</b> 1	63.4	31.6	95.0	22. 0
G44		66.7	33.3	100.0	35.0
G42		73.4	36.6	110.0	20.0
G41		80.0	40.0	120.0	15.0
G48		86.7	43.3	130.0	10,0

#### TABLE EVIII

#### FATIGUE TEST DATA

Material- PH 15-7 Mo RH950 Forging
Type of Specimen- Longitudinal Notched
Test Temperature-1000°F

Test Frequency-Cycles/Minute
A= -4300
A= 98 - 1800

A=. 98 - 1800 A=. 50 - 1800

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No.	Ratio	Sm	Sa	Sc	Kilocycles
H-14 H-21	Infinity	0	30, 0 32, 5	30, 0 32, 5	10,000.0+ 3,727.0
H-13 H-19			35.0 35.0	35, 0 35, 0	5,864.0 3,059.0
H-15			37.5	37.5 40,0	703. 0
H-12 H-17			40, 0 45, 0	45. 0	195. 0 59. 0
H-20 H-16 H-18			45.0 50.0 60.9	45, 0 50, 0 60, 0	33, 0 17, 0 10, 0
H-27 H-26 H-30 H-25 H-24 H-29 H-23 H-23 H-22	. 98	25.3 27.8 27.8 30.3 32.8 35.4 40.4 45.5	24. 8 27. 2 27. 2 29. 7 32. 2 34. 7 34. 7 39. 6 44. 6	50. 0 55. 0 55. 0 60. 0 63. 0 70. 0 70. 0 80. 0 90. 0	16, 390. 0+ 558. 0 451. 0 200. 0 102. 0 48. 0 26. 0 24. 0 7. 0
H-36 H-35 H-38 H-34 H-37 H-33 H-32 H-31 H-40	.50	45. 0 46. 7 50. 0 50. 0 53. 4 53. 4 56. 7 60. 0 66. 7	22. 5 23. 3 25. 0 25. 0 26. 6 26. 6 28. 3 30. 0 33. 3	67.5 70.0 75.0 75.0 80.0 80.0 85.0 90.0	10,022.0+ 5,834.0 2,848.0 258.0 2,749.0 124.0 30.0 23.0 12.0

Cycles/minute A= - 4300 Frequency Test Chart No.: Date: 000'000'0 Longitudinal, Smooth Specimen Finish-63 Microinches Environment - Air S-N Curve-PH 15-7 Mo RH 950 Forging FAILURE 1,000,000 Ultimate Tensile Strength - 234 KSI þ Tensile Yield Strength - 200 KSI TO. A = 8 Axial Sinusoidal Loading CYCLES Temperature - Room 8 ISa ANAXIMUM STRESS, 120,000 90,000 180,000 160,000 140,000 100,000 6,000 20,000 200,000 66,688

1

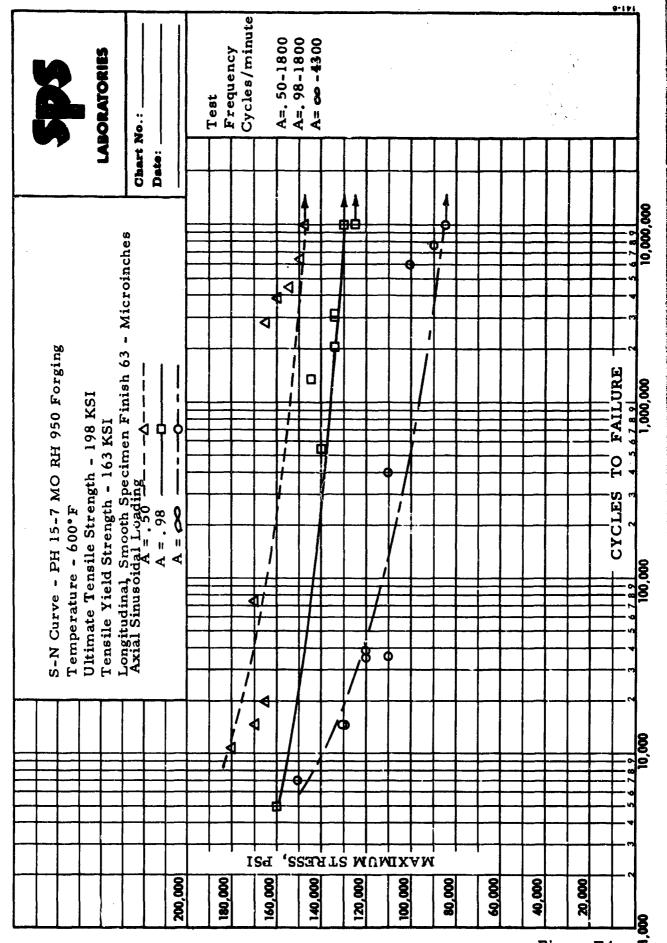


Figure E4

SPS	Chart No.:	Test	Cycles/Minute	A=. 98-1800 A=. 50-1800	A= ∞ -4300			T			T			
S-N Curve - PH 15-7 Mo RH 950 Forging  Temperature - 1000°F  Ultimate Tensile Strength - 126 ksi  Tensile Yield Strength - 101 ksi Longitudinal, Smooth Specimen, Finish 63-Microinches							4						CYCLES TO FAILURE	000
							#						3 4 5 6 7 8 9	000'01
	100		IS	a 'ss	<b>26</b> <b>26</b> 33 T	120,000 120,000	S S	-	90,000	60,000	8	20,000		98,

40.00

Cycles/minute A = 00 -4300 A=. 98-1800 A=, 50-1800 Frequency LABORATORIES Test Chart No.: Date: Longitudinal, Notched Specimen Finish - 63 Microinches 000,000,01 Environment - Air S-N Curve - PH 15-7 Mo RH 950 Forging FAILURE Ultimate Tensile Strength - 177 ksi TO K<sub>t</sub>=3.0 Axial Sinusoidal Loading Temperature - Room CYCLES A = . 50 A = . 98 MAXIMUM STRESS, **IS**d 160,000 100,000 200,000 180,000 120,000 40,000 20,000 140,000 80,000 60,000 Figure E6

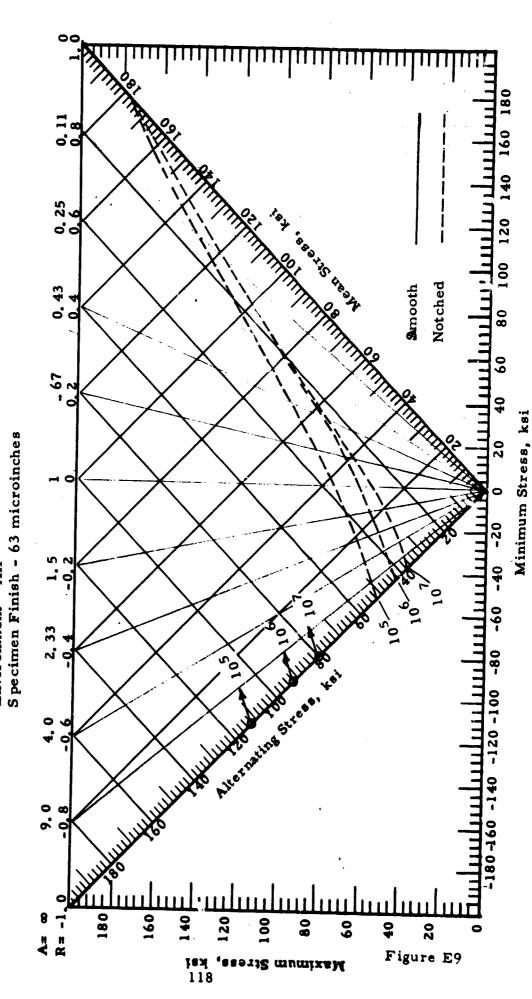
115

Cycles/minute A=. 50-1800 A=. 98-1800 A=00 -4300 Frequency LABORATORIES Test Chart No.: Date: 10,000,000 Longitudinal, Notched Specimen Finish-63 Microinches 4 S-N Curve - PH 15-7 Mo RH 950 Forging 400 TO FAILURE Ultimate Tensile Strength - 266 ksi 1,000,000 Axial Sinusoidal Loading Temperature - 600°F CYCLES A = . 50 A = . 50 A = . 50  $K_t = 3.0$ 0 MAXIMUM STRESS, Is'a 160,000 120,000 100,000 200,000 180,000 90,000 000'09 140,000 40,000 20,000 116

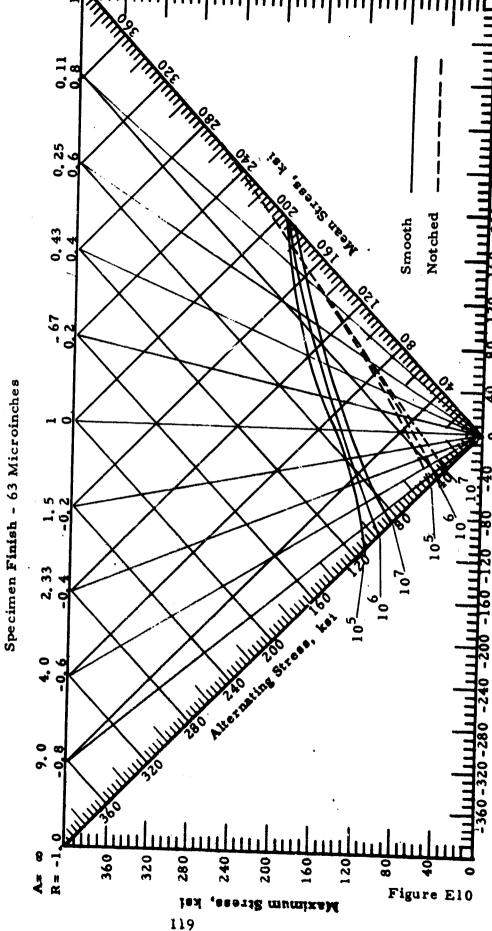
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SPS	9.:		Test	Cycles/minute	A=. 50 - 1800	A=. 76 -1800 A= \$6 -4300															*
3	Chart No.: Date:			Ĭ																7	
S-N Curve - PH 15-7 Mo RH 950 Forging Temperature - 1000°F Ultimate Tensile Strength - 179 ksi Longitudinal, Notched Specimen Finish-63 Microinches	<u></u> ,																				5 7 8 9
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Forging Environment - Air si Finish-63 Microind		<u>.</u>	+				-	<del> </del>	-	<del> -</del>		<del> -</del>	-	H			-	1	-	-	-7
S-N Curve - PH 15-7 Mo RH 959 Forging Temperature - 1000°F Ultimate Tensile Strength - 179 ksi Longitudinal, Notched Specimen Finish-6	1																			 Failure	
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S-N Curve - PH 15-7 Mo RH 950 For Temperature - 1000°F EUltimate Tensile Strength - 179 ksi Longitudinal, Notched Specimen Fi	inusoidal Loading																				3 4
S-N Curve - PH 15-7 N Temperature - 1000°F Ultimate Tensile Stren Longitudinal, Notched	Loa	1 1												Þ						CYCLES	
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CONSTANT LIFE DIAGRAM-15-7 Mo RH 950 FORGING Temperature - Room Ultimate Tensile Strength-Smooth 234 KSI, Notched 177 KSI Tensile Yield Strength - Smooth 200 KSI Axial Sinusoidal Loading Environment - Air



CONSTANT LIFE DIAGRAM - PH 15-7 Mo RH 950 FORGING
Tempera'ur - 600°F
U'timate Tensile Strength-Smooth-198 KSI- Notched (K<sub>t</sub>=3, 0)-266 KSI
Tensile Yield Strength-Smooth-162 KSI
Axial Sinusoidal Loading
Environment - Air



Minimum Stress, ksi

80 100 120 140 160 180 0, 11 Ultimate Tensile Strength - Smooth- 126 KSI-Notched (Kt=3.0)-179 KSI Tensile Yield Strength-Smooth-101 KSI materulamini 0, 25 0, 6 CONSTANT LIFE DINGRAM-PH15-7 Mo RH950 FORGING Notched Smooth 0, 43 9 79. Specimen Finish - 63 Microinches 105 Axial Sinusoidal Loading Temperature - 1600°F Environment - Air -60 1111 Still Week treet 2, 33 -186-160 -140 -120-100 -80 4.0 9.0 160 100 9 Figure Ell

Minimum Stress, ksi

### SECTION VF

## PH 15-7 Mo TH 1050 SHEET

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TABLE FI

TENSILE TEST DATA FOR PH 15-7 Mo, TH 1050 SHEET MATERIAL

d K <sub>t</sub> =3.0	Ult. Tensile Strength, ksi	185.8 186.6 189.0 187.1	188, 7 189, 5 191, 8 190, 0	94.8 85.5 90.3	85. 1 97. 2 109. 8 97. 4
Notched	Specimen	PA-7 PA-8 PA13	T34 T35 T36	PA10 PA12	T38 T40 T41
	Elongation in 2", %	5.5 6.4 6.3	4.5.0 5.0 8.8	16. 4 17. 0 20. 0 17. 8	15.0 16.0 18.0 16.3
Smooth	0, 2% Offset Yield Strength, ksi	144.8 146.6 153.3 148.2	167.0 151.0 165.7 161.2	84. 0 90. 7 77. 1 83. 9	76.8 76.1 89.6 80.8
	Ult, Tensile Strength, ksi	167. 3 166. 6 170. 6 168. 2	176. 4 174. 2 174. 1 174. 9	102.6 111.6 95.4 103.2	80.3 85.8 98.5 88.2
	Spec. No.	PA14 Q-1 Q-2	SA3 SA4 UA1	Q-3 Q-4 Q-5	UA2 UA3 UA4
<del></del>	Specimen Orientation	ı	Т	ı	H
	Test Temp.	700°F		1000° F	

TABLE FII

STRESS RUPTURE TEST DATA FOR PH 15-7 Mo,
TH 1050 SHEET MATERIAL - TRANSVERSE

Spec.		Test	Stress	Life
No.	K <sub>t</sub>	Temp.	<u>k</u> si	Hrs.
R33	1.0	700°F	168	0, 2
R 32			165	2.6
R 31			150	135.8
R30			145	187, 0+
R 29			110	193, 7+
R24	1.0	1000°F	60	22, 1
R25		1000 1	55	75.2
R27			52, 5	167.1
R 28			52. 0	179.5
R 26			50	191.3+
T14	3, 0	700°F	167. 0	9, 1
T12			166.	57.5
T11			165	100.1
T15	•	1	164	30.7
Т16			160	200.0
T18	3, 0	1000°F	68	11.8
T19	", "	1000 F	.65	18.1
TZI			60	61.0
T22			58	80.0
T17			56	184.5

# PH 15-7 Mo TH 1050 FORGING STRESS VS. TIME TO RUPTURE

Notched ----Smooth ----

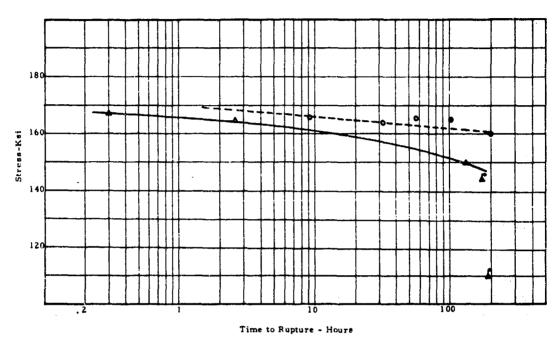


Figure F1-700°F

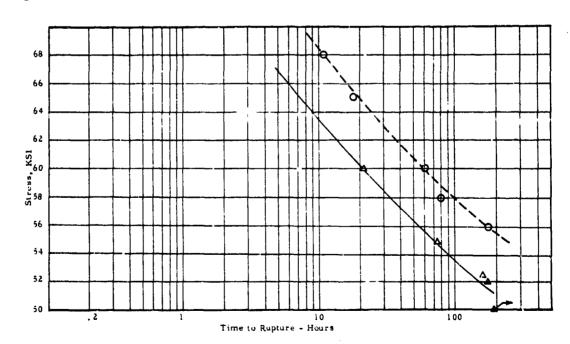


Figure F2-1000°F

#### TABLE FIII

#### FATIGUE TEST DATA

Material- PH15-7 Mo TH1050 Sheet Type of Specimen- Transverse-Smooth Test Temperature-700°F Test Frequency-Gycles/Minute A= .50-1200

A = .98 - 1200

Specimen	"A"	Appli	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles
SA39	0, 98	55.6	54, 4	110.0	30,044,0+
SA37		56.9	55.7	112.5	6,311.0
SA36		58.1	56.9	115.0	3,073.0
SA48		60.6	59. 4	120.0	4,833.0
SA46		60.6	59.4	120.0	1,705.0
SA49		63.1	61.9	125.0	21.0
SA38		65.7	64, 3	130.0	126.0
SA40		68.2	66, 8	135.0	31.0
SA47		70.7	69. 3	140.0	691.0
SA7	0.50	90.0	45.0	135.0	10,007,0+
SA6		93, 4	<b>46.</b> 6	140.0	3,822.0
SA14		96.7	48.3	145.0	6,428.0
SA15		100.0	50.0	150.0	3,483.0
SA8		103.4	51.6	155.0	3, 736. 0
SA13		103,4	51.6	155.0	1,862.0
SA12		106.7	53, 3	160.0	2,521.0
SAll		106.7	53.3	160.0	35, 0
SA9		108.4	54.1	162.5	34, 0
SA10	·	110.1	54. 9	165.0	18.0

#### TABLE FIV

#### FATIGUE TEST DATA

Material- PH15-7 Mo TH1050 Sheet Type of Specimen- Transverse-Smooth Test Temperature-1000°F

Test Frequency-Cycles/Minute
A\*. 50-1200
A=. 98-1200

Specimen	"A"	Appli	Life,		
No.	No. Ratio		Sa	Sc	Kilocycles
SA23 SA22 SA21 SA25 SA19	0.98	32.8 35.4 37.8 37.9	32. 2 34. 7 37. 1 37. 1	65.0 70 75 75	10,087.0 2,852.0 2,727.0 2,707.0
SA19 SA24 SA16 SA18 SA17		40, 4 42, 9 45, 5 45, 5 50, 5	39.6 42.1 44.6 44.6 49.5	80 85 90 90 100	1,566.0 807.0 22.0 12.0 Failed Loading
SA30 SA31 SA29 SA33 SA32 SA35 SA27 SA26 SA34	0.50	46. 7 50. 0 53. 4 56. 7 56. 7 60. 0 66. 7 73. 7	23, 3 25, 0 26, 6 28, 3 28, 3 28, 3 30, 0 33, 3 36, 6	70.0 75.0 80.0 85.0 85.0 90.0 100.0	10,695.0+ 2,361.0 526.0 2,208.0 465.0 188.0 81.0 43.0 23.0

#### TABLE FV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo TH 1050 Sheet Type of Specimen- Transverse Notched Test Temperature-700°F Test Frequency-Cycles/Minute A=. 50-1200 A=. 98-1200

Specimen	"A"	Appli	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles
R-8 R-19 T-47 R-7 R-6 T-48 R-5 R-4 R-3 R-2	. 98	20. 2 22. 7 25. 3 25. 3 30. 3 30. 3 35. 4 40. 4 45. 5 50. 5	19.8 22.3 24.8 24.8 29.7 29.7 34.7 39.6 44.6 49.5	40.0 45.0 50.0 50.0 60.0 70.0 80.0 90.0	10,302.0+ 10,570.0+ 6,212.0 31.0 14.0 9.0 12.0 6.0 3.0 3.0
T-27 T-29 T-26 T-30 T-28 T-25 T-31 T-32 T-23	.50	41.7 43.4 43,4 46.7 46.7 50.0 53.4 53.4	20.8 21.7 21.7 23.3 23.3 23.3 25.0 26.6 26.6	62.5 65.0 65.0 70.0 70.0 70.0 75.0 80.0	10,326.0+ 8,357.0 39.0 4,097.0 27.0 21.0 40.0 17.0 14.0

#### TABLE FVI

#### FATIGUE TEST DATA

Material- PH 15-7 Mo TH 1050 Sheet Type of Specimen- Transverse Notched Test Temperature-1000°F Test Frequency-Cycles/Minute A=. 50-1200 A=. 98-1200

Specimen	"A"	Appli	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles
T-8 T-7 T-9 T-6 T-5 T-4 T-3 T-2 T-1	. 98	15. 2 17. 7 17. 7 20. 2 22. 7 25. 3 27. 8 30. 3 32. 8	17. 7     17. 3       17. 7     17. 3       20. 2     19. 8       22. 7     22. 3       25. 3     24. 8       27. 8     27. 2		10,006.0+ 2,143.0 874.0 57.0 28.0 19.0 13.0 5.0
R-18 R-17 R-16 R-23 R-15 R-22 R-21 R-14 R-10 R-20	. 50	35.0 26.7 30.0 30.0 33.3 33.3 36.7 40.0 43.4	12. 4 13. 3 15. 0 15. 0 16. 7 16. 7 18. 3 18. 3 20. 0 21. 7	37.5 40.0 45.0 45.0 50.0 50.0 55.0 60.0	10,000.0+ 5,735.0 1,290.0 893.0 885.0 76.0 314.0 57.0 18.0 16.0

A=. 50-1200 A=. 98-1200 Frequency LABORATORIES Cycles/ Minute Test Chart No.: Date: 10,000,000 Transverse, Smooth Specimen Finish-63 Microinches Environment-Air 4 A=. 50 -----S-N Curve-PH 15-7 Mo TH 1050 Sheet 4 TO FAILURE Ultimate Tensile Strength-175 KSI 1,000,000 Tensile Yield Strength- 161 KSI Axial Sinusoidal Loading Temperature - 700°F A=. 98 CYCLES # Maximum Stress, ted 200,000 180,000 160,000 140,000 120,000 90,000 8 60,000 40,080 2000 Figure F3 130

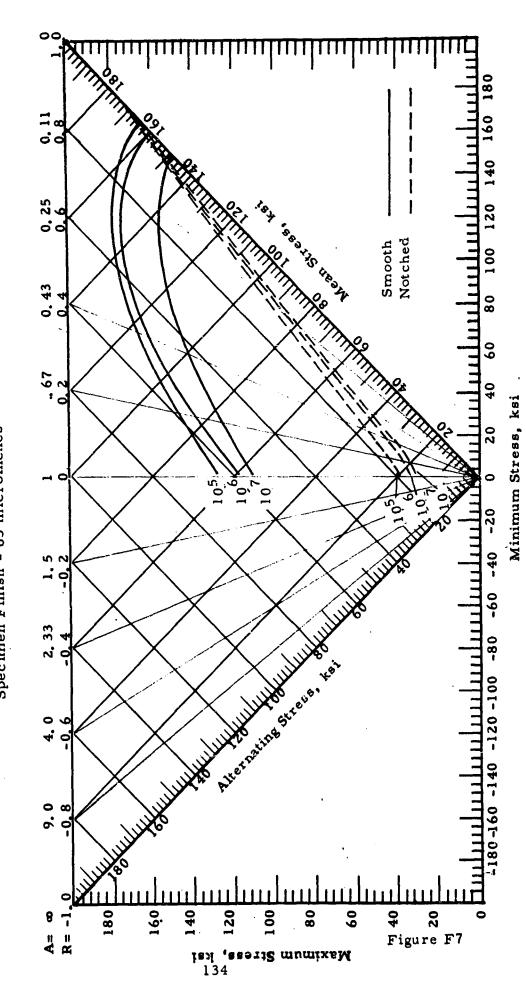
A=. 50-1200 A=. 98-1200 Frequency LABORATORIES Cycles/ Minute Test Chart No .: Date: Transverse, Smooth Specimen Finish-63 microinches Temperature-1000°F Environment-Air Ultimate Tensile Strength-88 KSI S-N Curve-PH 15-7 Mo TH1050 Sheet A=.50 ----TO FAILURE Tensile Yield Strength - 81 KSI Axial Sinusoidal Loading 4 A= . 98 CYCLES 4 STRESS, MUMIXAM ISd 180,000 140,000 120,000 100,000 90,00 60.000 200,000 40,000 20,000 Figure F4

Cycles/min. A=. 50-1200 A=. 98-1200 Frequency LABORATORIES Test Chart No.: Date: Transverse, Notched Specimen Finish - 63 microinches Environment - Air S-N Curve PH 15-7 Mo RH 950 Sheet TO FAILURE Ultimate Tensile Strength- 190 KSI Axial, Sinusoidal Loading A= . 98 — Temperature- 700°F CYCLES  $K_t = 3.0$ Stress 200,000 180,000 100,000 80,000 60,000 160,000 140,000 120,000 40,000 20,000 Figure F5 132

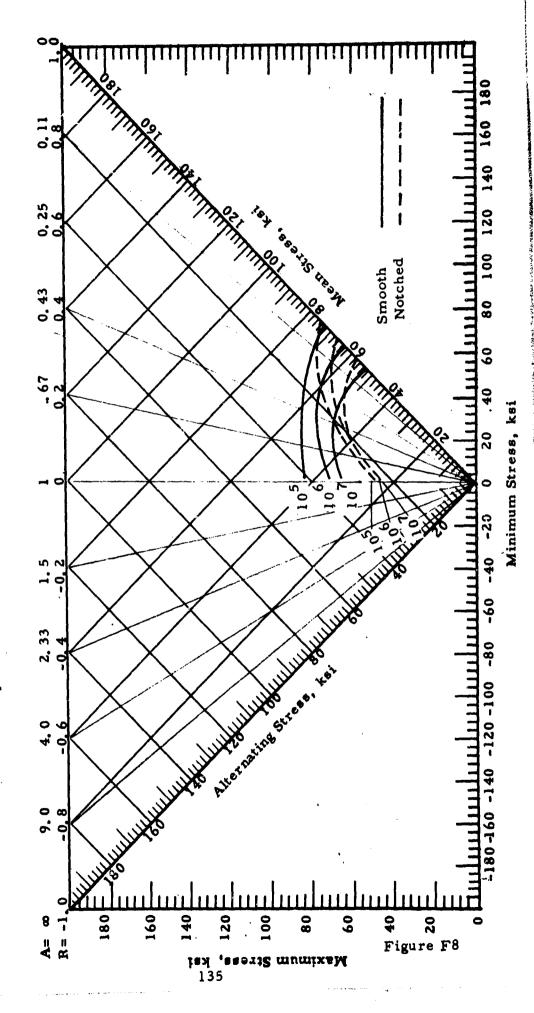
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A= .50-1200 A= .98-1200 Cycles/min. Frequency LABORATORIES Test Chart No.: Date: Transverse, Notched Specimen Finish-63 Microinches Environment - Air S-N Curve PH 15-7 Mo RH 950 Sheet FAILURE Ultimate Tensile Strength- 97 KSI A= . 50 --- A--- $K_t = 3.0$  Axial, Sinusoidal Loading JO Temperature- 1000°F CYCLES Stress, įsą 200,000 180,000 160,000 120,000 100,000 140,000 000,09 80,000 40,000 20,000 Figure F6 133

CONSTANT LIFE DIAGRAM- PH 15-7 Mo TH 1050 SHEET Temperature - 700°F
Ultimate Tensile Strength-Smooth 175 KSI, Notched 190 KSI Tensile Yield Strength- Smooth 161 KSI
Axial Sinusoidal Loading
Environment - Air
Specimen Finish - 63 microinches



CONSTANT LIFE DIAGRAM- PH 15-7 Mo TH 1050 SHEET Temperature- 1000°F.
Ultimate Tensile Strength- Smooth 88 KSI, Notched 97 KSI Tensile Yield Strength- Smooth 81 KSI
Axial Sinusoidal Loading
Environment- Air
Specimen Finish - 63 microinches



## SECTION VG

## PH 15-7 Mo TH 1050 FORGING

Tensile Results	Page No.
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Fatigue Results	
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Figure G4-S-N Curve-1000°F Smooth	147
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Figure G6-S-N Curve-1000°F Notched	1 49
Figure G7-Constant Life Diagram-700°F	150
Figure G8-Constant Life Diagram-1000°F	151

TABLE GI

TENSILE TEST DATA FOR PH 15-7 Mo, TH 1050 FORGING MATERIAL

•	Tensile ıgth, ksi	2 P 2 P 8	8 O D 3	4 1 9 0	2 2 2 0
$K_t = 3.0$	Ult. Tensile Strength, ksi	221. 8 224. 3 220. 5 222. 2	225, 3 224, 2 222, 0 222, 0	141, 4 145, 1 157, 6 148, 0	154, 2 143, 7 140, 2 146, 0
Notched	Specimen	D-15 D-16 D-17	L-1 L-2 L-3	D-18 D-19 D-20	L-4 L-5 L-6
	Reduction of Area,%	44.6 44.6 45.2 44.8	6. 1 26. 3 23. 4 18. 6	71.3 69.9 70.4 70.5	59. 0 60. 0 58. 0 59. 0
	Elongation in 1", %	12. 0 12. 0 12. 0 12. 0	5.0 8.0 8.0 7.0	22. 0 22. 0 25. 0 23. 0	23. 0 21. 0 20. 0 21. 3
Smooth	0, 2% Offset Yield Strength, ksi	158, 1 155, 6 153, 0 155, 6	155, 6 155, 1 150, 5 153, 7	97.9 94.3 100.0 97.4	93.3 97.9 93.8 95.0
	Ult. Tensile Strength, ksi	167. 3 166. 3 165. 3 166. 3	166.8 165.3 162.2 164.8	106, 1 104, 0 108, 1 106, 1	103, 5 108, 1 104, 0 105, 2
	Spec. No.	B21 B22 B23	K-1 K-2 K-3	B-24 B-25 B-26	K-5 K-6 K-7
	Specimen Orientation	7	T	т	H
	Test Temp.	700° F		1000°F	

TABLE GII

STRESS RUPTURE DATA FOR PH 15-7 Mo,
TH 1050 FORGING MATERIAL - LONGITUDINAL

Spec. Nc.	K <sub>t</sub>	Test Temp.	Stress, ksi	Life, Hrs.
B17 B19 B18 B15 B16	1.0	700°F	145 147.0 148 150 160	192.7+ 147.7 51.4 77.4 4.3
B31 B32 B30 B29 B28	1.0	1000°F	55. 0 58. 0 60. 0 70 80	187. 0+ 94. 7 92. 1 6. 8 0. 2
D21 D25 D24 D23 D22	3. 0	700°F	200. 0 202. 0 205. 0 210. 0 216. 0	214.0+ 43.6 33.6 27.8 6.9
D32 D14 D31 D28 D27	3.0	1000°F	65 75 80 110 130	189.6 242.9 33.6 1.2 0.2

## PH 15-7 Mo TH 1050 FORGING STRESS VS. TIME TO RUPTURE

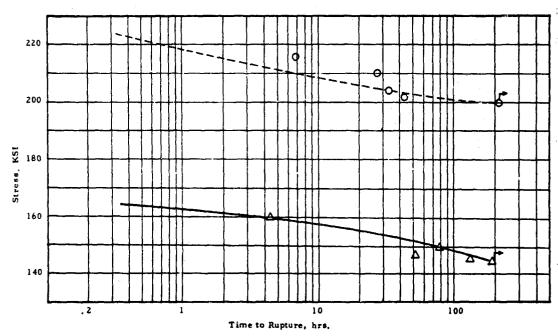


Figure G1-700°F

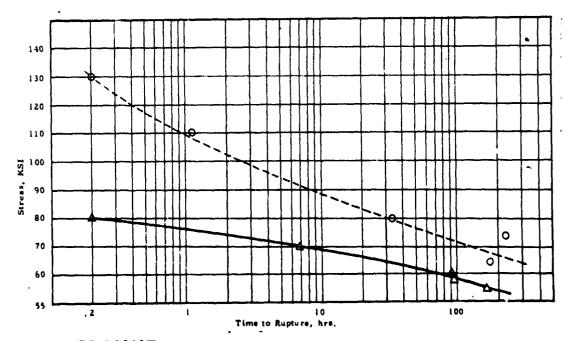


Figure G2-1000°F

## TABLE GIII

### FATIGUE TEST DATA

Material- PH 15-7 Mo TH1050 Forging Type of Specimen- Longitudinal Smooth Test Temperature-700°F

Test Frequency-Cycles/Minute

A = -4300

A=. 98 - 3500

A = .50 - 3500

Specimen	"A"	Appli	ed Stress,	ksi	Life,
No,	Ratio	Sm	Sa	Sc	Kilocycles
A4	Infinity	0	95. 0	95, 0	10,000.0+
A7			100.0	100.0	12, 180, 0+
A3	]		100.0	100,0	2, 939. 0
A10			102.0	102,0	95.0
A8			105.0	105.0	48.0
<b>A9</b>			105.0	105, 0	38, 0
. A6			110.0	110.0	27. 0
A2			120.0	120.0	16.0
<b>A</b> .5			130,0	130.0	4.0
Al			140.0	140.0	2, 0
A27	0.98	63. 1	61.9	125, 0	19, 706. 0+
A30		65.7	64.4	130.0	10, 341.0+
A25		65.7	64. 4	130.0	300, 0
A26	Ì	68. 2	66.8	135, 0	487.0
A24	1	68.2	66.8	135, 0	40.0
A21		70.7	69.3	140.0	280, 0
A28		73. 2	71.8	145.0	1,631.0
A22		75.8	74. 2	150, 0	28, 0
A23	1	78.3	76.7	155, 0	29.0
A29		80,8	79. 2	160, υ	18.0
A11	0, 50	86. 7	43, 3	130, 0	10, 000, 0+
A19		100.0	50, 0	150.0	10, 042, 0+
A12		100.0	50.0	150.0	2, 303. 0
A15	1	103.4	51.6	155.0	10, 005, 0+
A18		103.4	51.6	155.0	8, 703. 0
A17		105.0	52, 5	157, 5	6, 394. 0
A20		105.0	52, 5	157.5	51,0
<b>A</b> 16		106.7	53, 3	160.0	29. 0
A13		106.7	53, 3	160. 0	21.0
A14		110.0	55. 0	165.0	25.0
					1

#### TABLE GIV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo TH 1050 Forging Type of Specimen- Longitudinal Smooth

Test Temperature- 1000°F

Test Frequency-Cycles/Minute

A= 00 -4300

A= .98 - 3500

A = .50 - 3500

Specimen	"A"	Appli	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles
A35	Infinity	0	60.0	60. 0	16, 632, 0+
E34			65, 0	65.0	5, 394, 0
A33	i i		70.0	70.0	342, 0
A31	Į i	!	75.0	75.0	1,725.0
E36	1		75.0	75.0	1,441.0
A32			80.0	80, 0	257.0
E40			85.0	85, 0	25. 0
A37			90.0	90.0	33, 0
A38			95.0	95.0	21.0
E39			110.0	110.0	3, 0
A42	0.98	42, 9	42, 1	85, 0	18, 494. 0+
A41		45.5	44: 6	90.0	1,870.0
A49		48.0	47.0	95.0	10, 269, 0+
A48	1	50.5	49.5	100, 0	6, 161. 0
A43	<b>!</b>	50, 5	49.5	100.0	4, 978, 0
Bl		53, 0	51.9	105.0	543, 0
A47		<b>53.0</b>	51.9	105.0	134.0
A44	ľ	55.6	54.5	110.0	418, 0
A45		60, 6	59. 4	120, 0	56. 0
A46		63, 1	61.8	125.0	16. 0
B8	0.50	50. 0	25, 0	75, 0	10,061,0+
B7		53, 4	26.6	80, 0	2,047,0
В6		56.7	28.3	85. 0	438, 0
B4	1	60.0	30. 0	90, 0	592, 0
В9		63.4	31.6	95. 0	10, 374, 0+
<b>B</b> 5		66.7	33, 3	100.0	168.0
Ble		70.0	35. 0	105.0	183.0
B3		73, 4	36.7	110.0	91.0
B2		80.0	40, 0	120, 0	96.0

#### TABLE GV

#### FATIGUE TEST DATA

Material- PH 15-7 Mo TH 1050 Forging
Type of Specimen- Longitudinal Notched
Test Temperature- 700°F

Test Frequency-Cycles/Minute

A= -4300 A= .98-3500 A= .50-3500

Specimen	"A"	Appli	Life,		
No.	o, Ratio S		Sa	Sc	Kilocycles
C25	Infinity	0	40.0	40, 0	10,000,0+
C26	]		42.5	42.5	7,878,0
C24			45.0	45. 0	2,775.0
C30			50.0	50, 0	156.0
C23			50.0	50,0	59.0
C22			55.0	55, 0	37.0
C29		i	60.0	6Q, 0	23.0
C21	]		60,0	60, 0	22.0
C28			65.0	65. 0	22.0
C27			70.0	70, 0	11.0
C45	0.98	32, 8	32, 2	65. 0	15, 531, 0+
C46		34, 1	33, 4	67.5	10, 375, 0+
G44		35, 4	34.6	70.0	62.0
G47		37.9	37, 1	75.0	10, 113, 0+
DS		39. 2	38, 4	77.5	417.0
C49		39. 2	38. 4	77, 5	72.0
C48		40, 4	39.6	80,0	51.0
C43		40. 4	39.6	80.0	48.0
ום	i	42. 9	42, 1	85.0	37.0
D3		45, 5	44, 5	90. 0	35.0
D8	0 . 50	63, 4	31, 6	95, 0	10, 209. 0+
D10	1	65.0	32, 5	97.5	11,601.0+
D9		65. 0	32.5	97.5	46.0
D7		66.7	33, 3	100, 0	85.0
D6	1	70.0	35, 0	105.0	39.0
DU	1	70.0	35. 0	105.0	27.0
D5		73.4	36.6	110.0	52.0
D4	}	76.7	38. 3	115.0	26, 0
DIZ	l	80.0	40, 0	120.0	17.0

#### TABLE GVI

#### FATIGUE TEST DATA

Material- PH 15-7 Mo TH 1050 Forging Type of Specimen- Longitudinal Notched Test Temperature-1000°F Test Frequency-Cycles/Minute
A= -4300

A= -4300 A= .98 3500

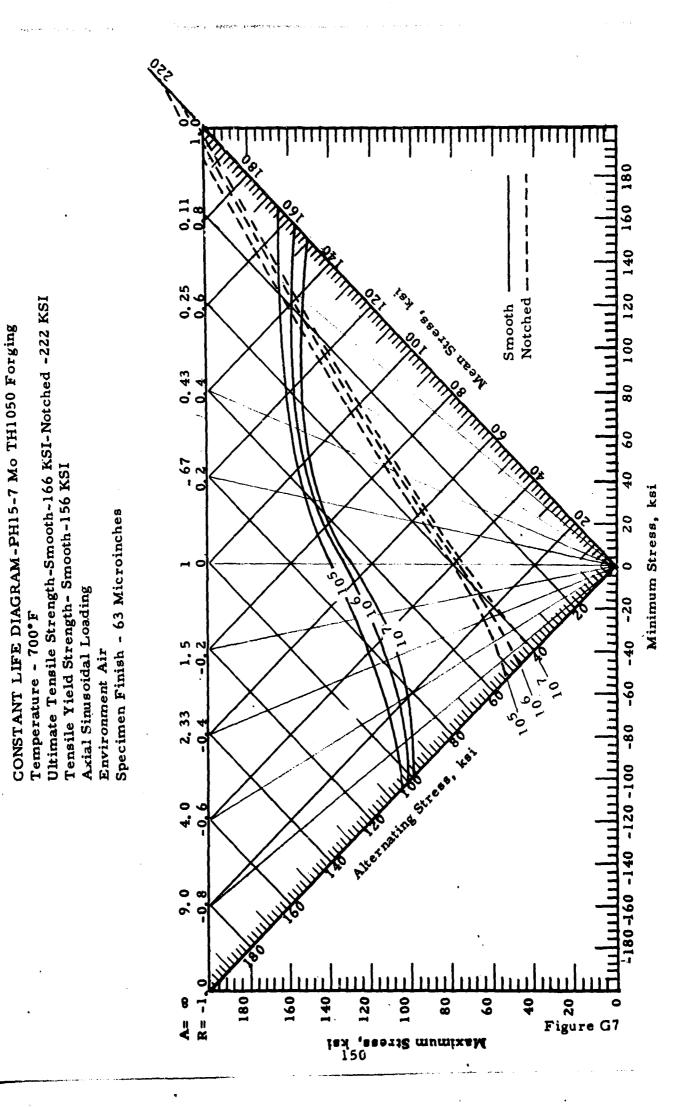
A=.50 3500

Specimen	"A"	Appli	ed Stress,	Life,		
No.	Ratio	Sm	Sa	Sc	Kilocycles	
C 42 C 41	Infinity	0	25, 0 27, 5	25. 0 27. 5	12, 911. 0+ 5, 327. 0	
C36			30.0 32.0	30.0	4, 411.0	
C33 C32			35.0	32. 0 35. 0	4, 141 . 0 823, 0	
C31			40,0	40.0	124.0	
C38			45.0	45.0	36.0	
C34	1		50.0	50.0	29.0	
C35			55.0	55.0	12.0	
C37			60.0	60.0	9,0	
C5 C4 C3 C1 C8 C2 C10 C9 C6	0.98	26. 5 26. 5 27. 8 30. 3 32. 8 35. 4 37. 9 37. 9 40. 4 45. 5	26. 0 26. 0 27. 2 29. 7 32. 2 34. 7 37. 1 37. 1 39. 6 44. 6	52. 5 52. 5 55. 0 60. 0 65. 0 70. 0 75. 0 75. 0 80. 0 90. 0	10,012.0+ 4,272.0 8,057.0 1,776.0 305.0 158.0 51.0 28.0 31.0	
G19 G18 G17 G16 G15 G14 G13 G12 G11 G20	0.50	41, 7 43, 4 45, 1 46, 7 48, 4 50, 0 53, 4 56, 7 60, 0 66, 7	20. 8 21. 7 22. 5 23. 3 24. 2 25. 0 26. 6 28. 3 30. 0 33. 3	62. 5 65. 0 67. 5 70. 0 72. 5 75. 0 80. 0 85. 0 90. 0	13, 924, 04 3, 414, 0 1, 438, 0 3, 666, 0 899, 0 1, 345, 0 360, 0 219, 0 114, 0 13, 0	

SPS	Chart No.:	Test	Frequency Cycles/minute	A=. 98 -3500 A=. 98 -3500 A=. 0-4300		<b>T</b> 1			1			7	J-101
5-7 Mo ' 500°F Strengt rength-9	A=, 50		Set SS	ZYLKE	, WU,							CYCLES TO FAILTIBE	4
	200,000	180,000	160,000	40.000	000 021	100,000	80,000	60.000		8	20,000	+	1

SPS	Chart No.:	Test	Frequency Cycles/minute	A=, 50-3500 A=, 98-3500	A= co -4300		<del>-</del> T	T	T		T	<u> </u>				
rging  Environment - Air  Finish - 63 Microinches	Chart Date:								1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							3 4 5 6 7 8 9
15-7 Mo TH 1050 Forging 700°F Le Strength - 222 ksi Notched Specimen Finish - 63															TO FAILURE	1 5 6 7 8 9 6 2
oH e - nsi	Axial Sinusoidal Loading A= . 50 A= . 98	B = 4						d'							Sarche HIII	- (
S-N Curve F Temperatur Ultimate Te Longitudina K <sub>t</sub> = 3.0	Axial S						•	4 1 1		1	08	6				10 000
		200,000	180,000	[Sd 000 091	ESS,	_	120,000 🔀		X A IV	000.08	900.09		40,000	20,000		2 3 4 5 6 7

SPS	Chart No.:		Test Frequency	Cycles/minute		A= 00 -4300												191	
S-N Curve PH 15-7 Mo TH 1050 Forging Temperature - 1000°F Ultimate Tensile Strength-148 ksi Longitudinal, Notched Specimen Finish-63 Microinches K <sub>t</sub> =3.0		A= ~										<i>i i i i i i i i i i</i>					CYCLES TO FAILURE	4 5 6 7 8 9 2 3 4 5	
										+	•	<i>k</i>	9	8				3 4 5 6 7 8 9	10.000
		200,000	<del></del>	Sď	160,000 v.		140,000 T	 120,000	IX	100,000 X		80,000	000,09		40,000	20,000		- 7	900



100 120 140 160 180 0, 11 Notched-0,25 Smooth 0, 43 0, 4 9 . 67 Minimum Stress, ksi Specimen Finish-63 Microinches -40 -20 1.5 -60 2, 33 -180-160 -140 -120 -100 -80 9.0 180 160 100 A= 8 Figure G8 R = -1151 eri2 mumixeM

Ultimate Tensile Strength-Smooth-106 KSI-Notched-148 KSI

Temperature - 1000°F

Tensile Yield Strength-Smooth- 97 KSI

Axial Sinusoidal Loading

Environment-Air

CONSTANT LIFE DIAGRAM-PH15-7 Mo TH1050 Forging

Unclassified

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to obtain fatigue data for alloys which	•	•	1
which fatigue data is currently lacking	· .		•
with the MIL-HDBK-5 format and ar	~	_	= ;
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